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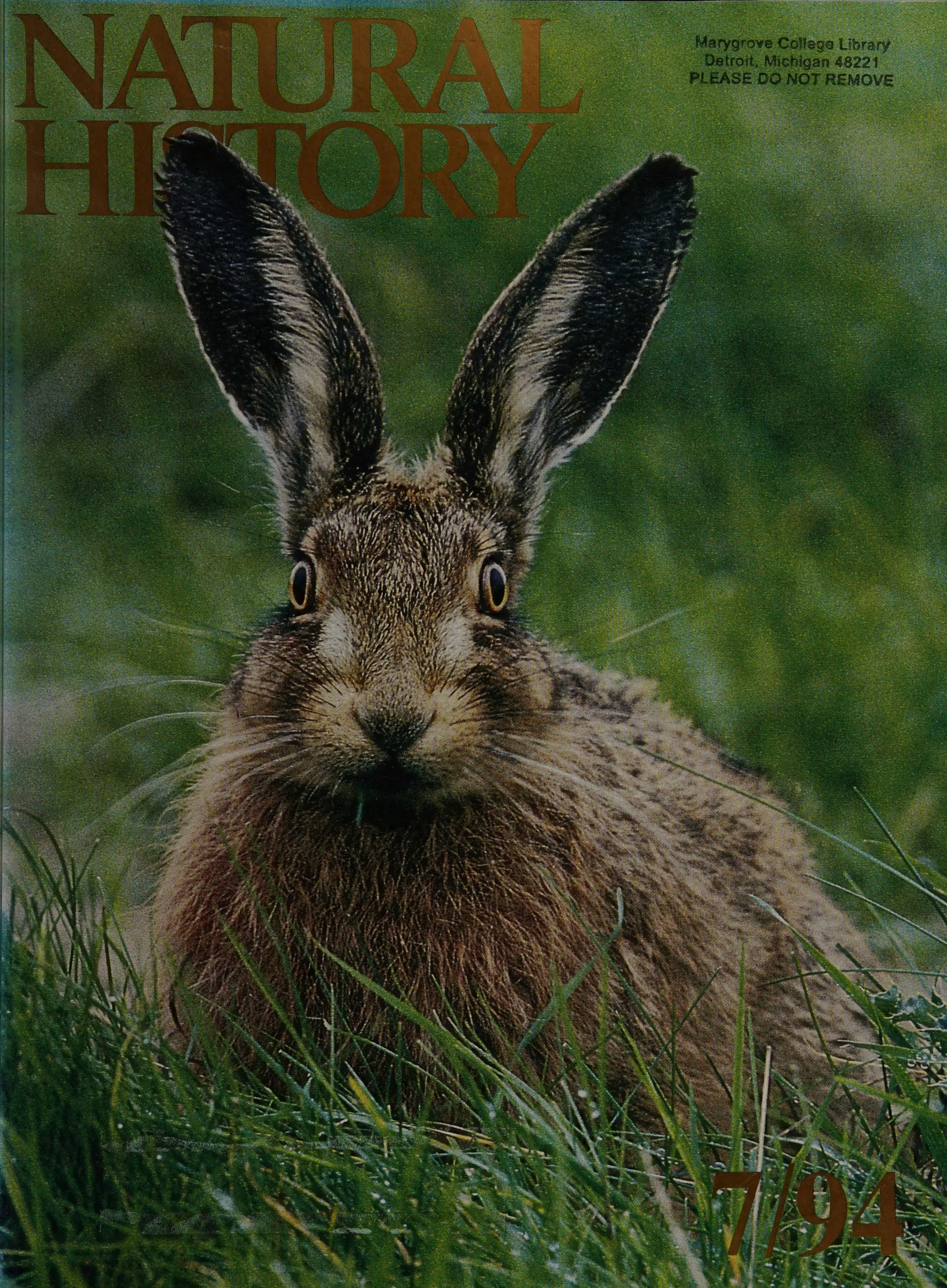

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COVER: *A European brown hare in a meadow stays alert to danger. If it sees a dog, it usually crouches; but if it sees a fox, it often stands. Why? Story on page 42. Photograph by E.A. Janes.*

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Give Me Your Shelled, Your Clawed

Geerat J. Vermeij

On a misty summer morning, a tidal pool on the coast of Maine may seem timeless and tranquil, but it is neither. Over geologic and historic time, many marine organisms have gone extinct along the Atlantic coast of North America. New species from around the world have invaded our shores, radically changing the mix of occupants and even the appearance of the seaweed. Humans have caused many changes in recent centuries. To unravel these life-and-death tales, scientists carefully study fossils, the tidal pools' current inhabitants and their relatives, and old shell collections squirreled away in museum drawers.

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No Hide, No Seek

Tony Holley

The fox is a dangerous predator for the brown hare in Europe. So why, wondered a nocturnal naturalist, does a hare stand up conspicuously on its hind legs when a

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fox approaches? After observing thousands of hours of interactions on the Somerset plains of England, he concludes that the hare is telling the fox, "I see you. Don't waste your energy—or mine—by chasing me, since I can run faster than you can."

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Terns on Tar Beach

Jerome A. Jackson

With humans crowded onto the beaches where birds traditionally nest, some determined least terns in Mississippi have taken to the roof of a shopping center to raise their young. Sun-baked tar roofs are not ideal sites. The terns' feet get burned. Fish crows snatch eggs and chicks. But the lack of predacious dogs and cats is a plus, as is the steady supply of water from roof-top air conditioners on hot days.

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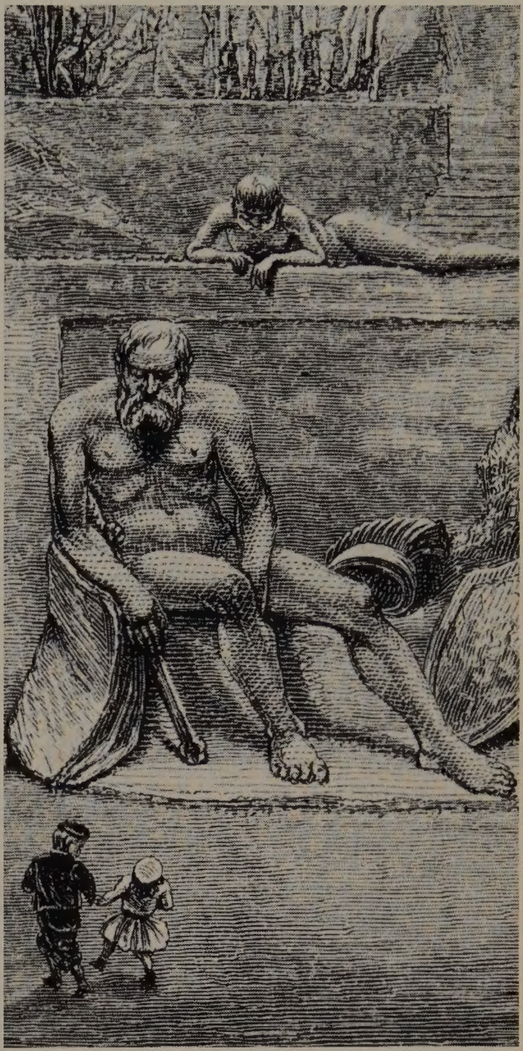
When the New Year Comes Twice

Li Weibao

In southwestern China, one of the nation's fifty-five minority groups celebrates the New Year twice a year. Dates for the two festivals come from one of the oldest known calendars in the world. Threads of ancient rituals remain, but the timing and events of the ceremonies have changed because of astronomical shifts over thousands of years, population growth and dispersal, modernization, and the disappearance of wild animals and trees.



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God's Own Scientists

A creationist study group grapples with Darwin

by Christopher P. Toumey

On the second Thursday of the month, for nine or ten months each year, a small number of men gather at the comfortable suburban home of a science professor at a major North Carolina public university. The group's object is the serious study of the scientific case for creationism, and its regular members include another science professor from the same university, a computer engineer, an electronics technician, two lab scientists, and two medical doctors. Others who attend occasionally are college students, electrical engineers, and more lab scientists. Preachers come by rarely.

The participants begin to arrive about 7:15 in the evening and proceed to a paneled den at the back of the house. There they chat about jobs and families, trading comments about computer software, laboratory procedures, and their children's schools, or they browse through *National Geographic, American Scientist,* or evangelical magazines such as *Christianity Today* and *Moody Monthly*. When all who are expected have arrived, the second science professor begins the meeting with an evangelical prayer, in which he asks God to bless their evening together and enlighten them.

Since many in the group also attend weekly Bible study groups on Wednesday nights at their homes or churches, the lessons from those meetings often influence the Thursday sessions. For example, over many months (while I attended as an anthropologist—and evolutionist—researching creationism in modern America), they kept up an irregular commentary on the meaning of the Hebrew word *yom,* which is the word for *day* in the six days of Creation in Genesis. In modern creationist orthodoxy, as handed down by Henry M. Morris, a former engineering professor in southern California, the days of Creation are literal, twenty-four-hour days. To discourage figure-of-speech interpretations of *yom,* Morris teaches that *yom* has the same meaning in every biblical verse in which it appears. Members of the study group follow Morris's teachings, and some attend conservative Bible study groups that take a similar, literalistic interpretation. Others, who attend less structured Bible study groups, say they have heard that *yom* usually means twenty-four hours, but that it sometimes could be a figure of speech, as in, "In the day of prosperity be joyful" (Eccl. 7:14) or "the day of the Lord" (Isa. 2:12).

Mostly, however, the meetings are technically oriented, as the participants seek to relate scientific evidence to creationism. At the first meeting I attended, the topic was the cosmological theory of the inflationary universe as proposed by physicist Alan Guth. The leader of the discussion, the science professor who hosted the group, began by summarizing several articles he had read recently in *American Scientist, Science,* and *Scientific American.* Neither he nor anyone else in the room claimed any special expertise in astrophysics; they behaved like any other curious group of intelligent nonphysicists trying to understand new developments in physics. No one tried to make Guth's model conform to biblical imagery; no one even mentioned the Bible during that evening's discussion.

Henry Morris and his followers believe that the six-day Creation and Noah's Flood were historical events whose authenticity supports a conservative interpretation of Judeo-Christian morality. They also believe, however, that scientific evidence for the Creation and the Flood can be distinguished from the words of Genesis. This data, they argue, can be honestly studied and taught as science in the public schools without violating the constitutional separation of church and state. With this reasoning, the members of the discussion group want their arguments on behalf of creationism to be scientifically credible, and they worry about this very much.

For example, one of the participants became interested in the theories of Barry Setterfield, an Australian creationist who asserts that the speed of light was much greater in the past, but that it has since decreased, leveling off fairly recently at the rate we know today, about 186,000 miles per second. Setterfield's calculations dovetail nicely with certain creationist chronologies that say the universe is less than 10,000 years old. But one of the group leaders cautioned against Setterfield's theory. He had asked Henry Morris about it, he said, and Morris had told him that the staff physicist at Morris's Institute for Creation Research was very skeptical about Setterfield. After that, they did not raise the subject again.

Often the evening emphasizes an educational program, of about an hour's length, produced by Henry Morris's institute—a film, tape, or, most typically, a slide show. These packaged programs tell the group little that they have not already heard, but the members nevertheless study the messages carefully, for they will be expected to bring these programs to their own Bible study groups, Sunday schools, and churches. Five or six of the members

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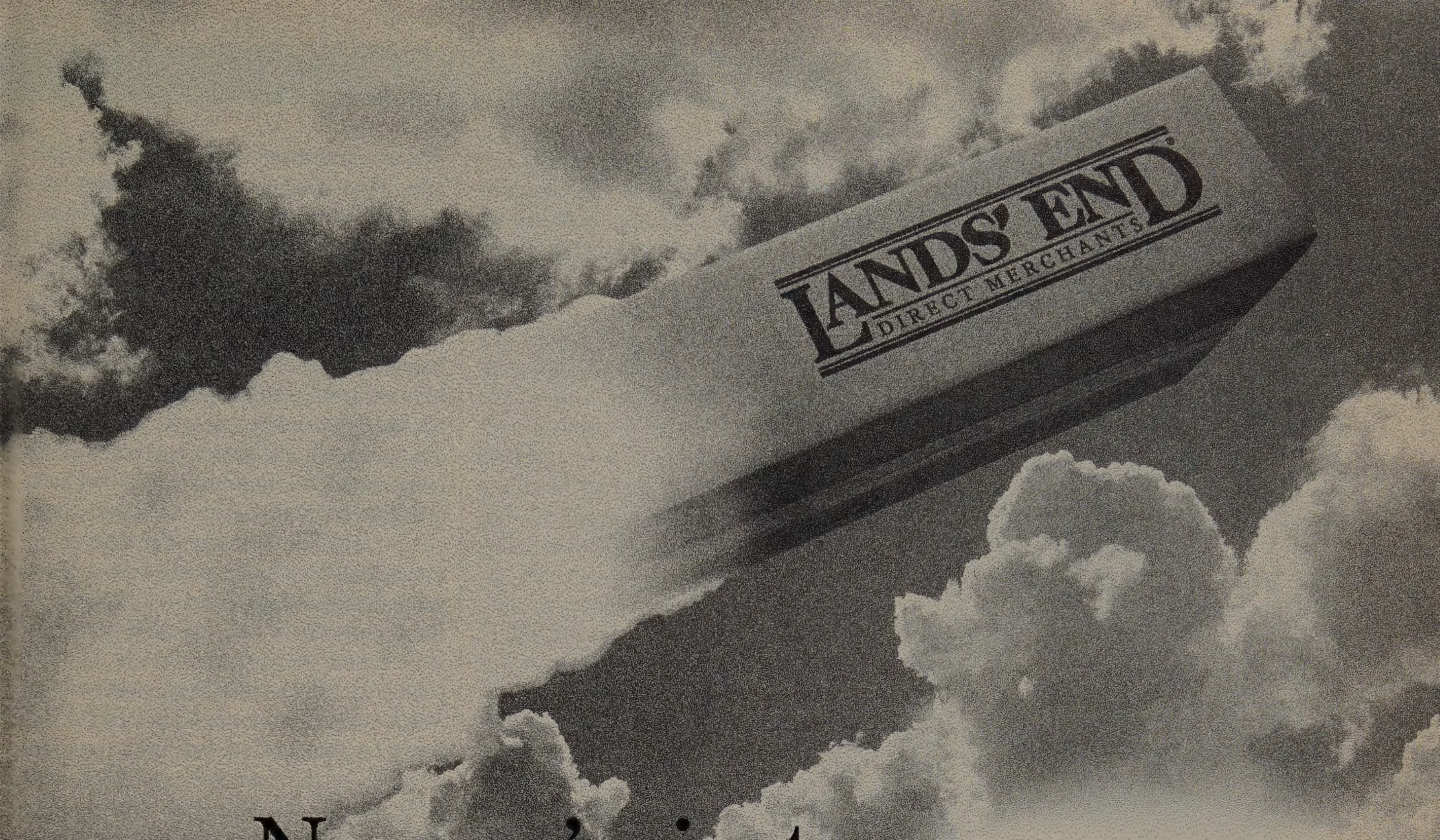
Adapted from *God's Own Scientists: Creationists in a Secular World,* by Christopher P. Toumey (New Brunswick: Rutgers University Press, 1994)



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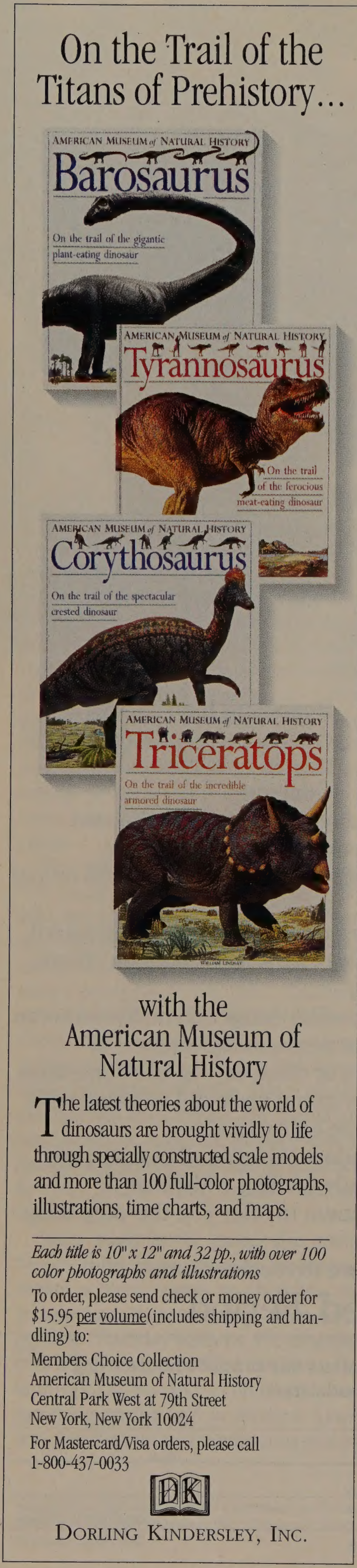
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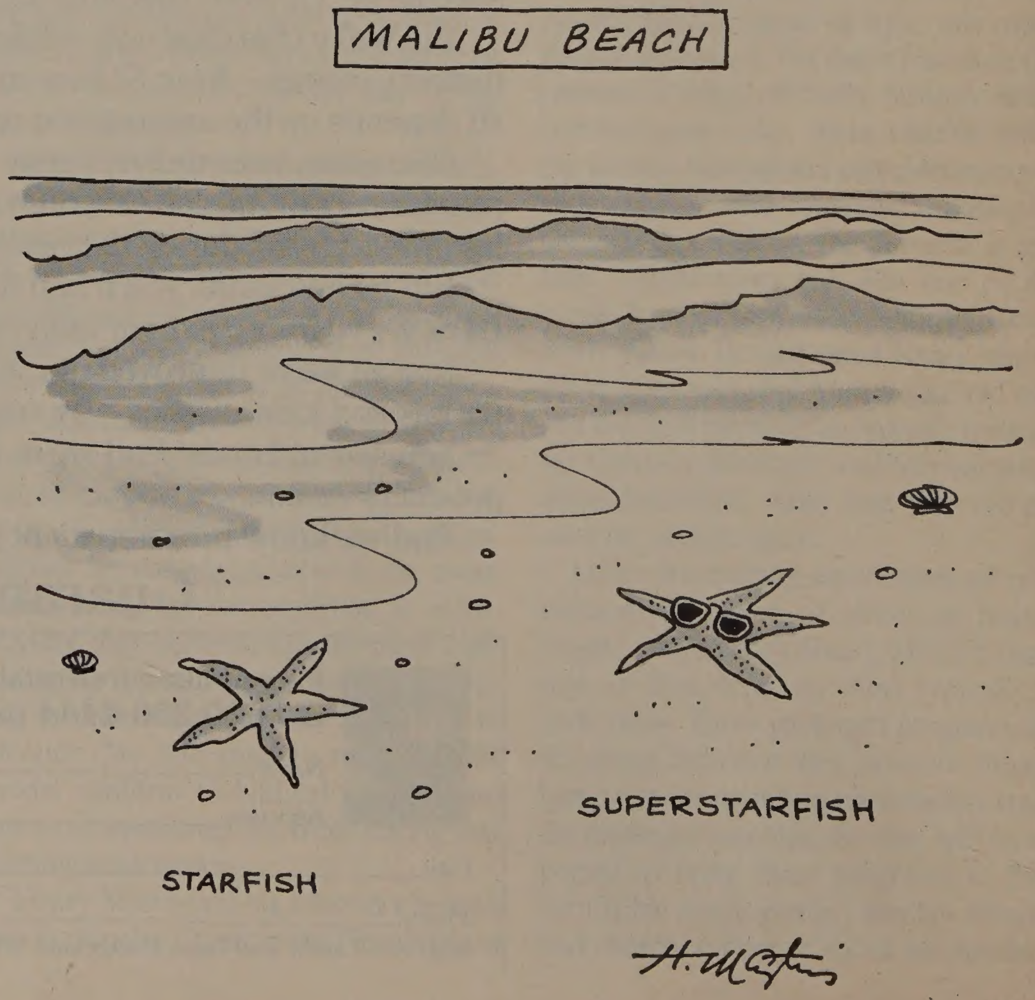
have spoken often in public on behalf of scientific creationism, so they are comfortable rearranging and editing these materials to suit themselves, but otherwise they defer very modestly to Morris's authority, which they never challenge.

The creationists turn to Henry Morris for more than just technical expertise: he is their hero, their inspiration. One of the founders of the group, an electronics engineer, traces his commitment to scientific creationism to the time he met Morris in San Diego. He says he was greatly impressed that Morris, a distinguished fellow engineer, explained creationism and the problems of evolution in terms of their common professional standards; before that, he had thought that creationism was only a religious idea.

These creationists also admire Henry Morris for several biblical commentaries he has written, one on Genesis and another on Revelation. They play no role in the group's scientific discussions because their content is traditional biblical exegesis, not technical information, but these volumes remind the local creationists that Morris is a spiritual leader, as well as a scientific authority. They say to one another that it's amazing that one man can do so much. This kind of comment then leads into folklore about the life of Henry Morris. According to one story I heard several times, Morris is a workaholic who, fortified by strong coffee, often stays up all night writing. Another tells of Morris's anguish over a son who was dissolute and disrespectful, but who, because of Morris's perseverance in his ministry, had a change of heart and became a reputable Christian.

One memorable evening, in place of the usual format, the group arranged for space at a church and invited the public to a special presentation by a man they had heard was a good creationist speaker. About fifty people came to hear Arleton C. Murray, a short, pudgy man with receding gray hair, who called himself Mr. Fossil. He appeared wearing a khaki bush jacket with a *Tyrannosaurus rex* embroidered on the left breast, a small badge reading "Creation scientist" on the right lapel, and a Gideon's badge on the left lapel (the Gideons are Christian businessmen best known for distributing Bibles to the public).

After the opening prayer and a vague introduction, Mr. Fossil explained that many years earlier he had been a fossil preparator in the Department of Vertebrate Paleontology at the Smithsonian Institu-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tion. He had been very interested in nature ever since childhood, he said, but he was told that "it never had God behind it." While at the Smithsonian, "I didn't know about Jesus Christ as my savior. I used to annoy prayer meetings; I was interested in drinking liquor and smoking cigars." One night, he continued, he went to an evangelical revival in Greenbelt, Maryland, intending to scoff at the preacher. Instead, he told us, he was moved by the things the preacher said and became a Christian that night. Soon afterward, he started speaking out against evolution.

He went on to say that the Smithsonian paleontologists heard about an antievolutionary talk he gave at Washington Bible College. His boss confronted him the next day, demanding that he cease such activities. "He said I had to, but I said I didn't have to, and I just walked out and never went back."

From this point on, Mr. Fossil illustrated his talk with exciting slides of his finding dinosaur fossils, excavating them, and reassembling them at the museum. As he related his fossil-finding experiences in Nebraska and Panama, he easily won the respect of the audience: here was a creationist who undoubtedly was a scientist.

Next he launched a venomous attack on evolution. "All museums teach the doctrine of evolution," he said. "They're all Karl Marx." He declared that "Fossils are the Waterloo of evolution," that the fossil rooms of the museums are "taboo to the public; they might find out something.... Evolution is a fake and a lie of the Devil.... Evolutionists actually believe a watch would evolve from a hairspring and filings."

This was fundamentalist preaching at its finest, faithfully following the classic pattern of first confessing a sinful life, then describing the personal conversion, and finally atoning by exposing the lurid secrets of the evildoers. But Mr. Fossil was not through yet. After dismissing evolution, he led the audience through his own scientific case for creationism. Fossils, he said, are evidence of the Flood. For example, the deposits at Agate Springs, near Carnegie Hill, in Nebraska contain numerous species together. "Only a great catastrophe like a flood could mix them all together like this." Furthermore, the fossil forms of leaves, shrimps, tapirs, and starfish are just like today's forms, showing no sign of change.

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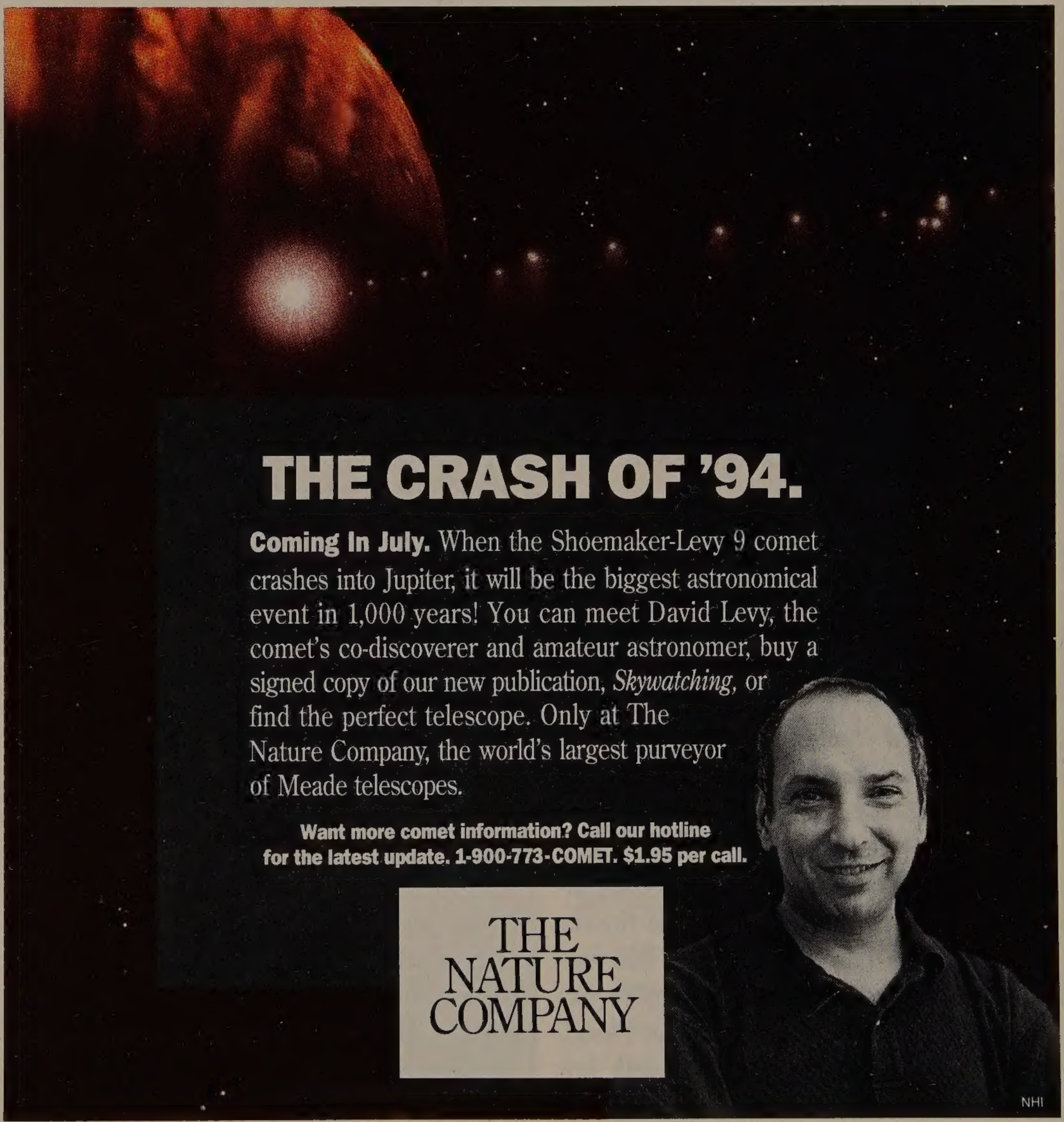

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By this point, the members of the local creationist group were beaming, enjoying every minute of this presentation. But as he neared the end of his talk, Mr. Fossil declared that dinosaurs and men had never lived together. Dinosaurs did not become extinct in Noah's Flood, he explained; they perished in a previous catastrophe he called Lucifer's Flood. After that, the world became "without form, and void" (Gen. 1:2). The six-day Creation, according to Mr. Fossil, was consequently a re-creation of the earth and its creatures, now including man.

I don't think many in the audience noticed anything amiss in this explanation, but I saw that the local creationist leaders were aghast. In terms of Henry Morris's creationist orthodoxy, Mr. Fossil was presenting the heresy called Gap Theory, meaning there was a long period of time, a gap, between the events of the first and second verses of Genesis. Thus many geological changes could have happened before the six-day Creation. Still worse, Mr. Fossil then attacked Henry Morris personally, saying, "Morris and his friends know nothing about fossils; Morris is an engineer, not a paleontologist."

Mr. Fossil justified his own theory of Lucifer's Flood by saying it came to him "as the spirit moved me." This was a perfectly credible explanation to most in the fundamentalist audience, but wholly out of place to those sensitive to issues of scientific evidence. After a very brief question-and-answer session, the moderator, who was plainly rattled by Mr. Fossil's comments, abruptly ended the evening's program by saying meekly, "Well, uh, this shows you that not all creationists agree on everything."

At the group's next meeting, the previous month's debacle was the first item of discussion. One of the leaders said he had asked some people about Mr. Fossil and had a story to tell. It seemed that Henry Morris had once been on the verge of having Mr. Fossil run the Institute for Creation Research's Museum of Creation, which at that time consisted of four small rooms at the back of the institute's headquarters. Morris apparently did not anticipate Mr. Fossil's views on biblical floods, and Mr. Fossil had not yet seen the museum displays, which categorically excluded Gap Theory and Lucifer's Flood. At first the two men hit it off well, but when Mr. Fossil saw the exhibits, he sized up the situation and left quickly, never to return. At this, the local creationists listening to the story laughed. The tension had been broken. True, they had let themselves be hoodwinked by Mr. Fossil, but so had Henry Morris. With this perspective, their embarrassment wasn't so bad after all.

The same evening, they turned to a slide show that discussed adaptation in the natural world. The show had two things to say about adaptation. First, adaptation is evidence of God's design. When a creature's behavior and anatomy are intimately related to the environmental conditions around it, this can be interpreted to mean that God has planned the natural world very carefully. Second, the slide show distinguished adaptation from speciation, calling the first "microevolution" and the second "macroevolution." It accepted that adaptation occurs, and that it is observable, giving the classic example of the English peppered moths, wherein scientists documented a dramatic change in the proportion of darker colored moths in the population. The creationist position was that this was only microevolution, and provided no support for the view that new species evolve.

In the group's discussion following the slide show, one of the creationists surprised me by saying very emphatically that the case of the peppered moths proves what the evolutionists allege about adaptation; he went on to say that he believed in *some* evolution, that *some* evolution does occur. Another then chimed in to say that natural selection occurs regularly in nature, just as the evolutionists claim it does. From this exchange and others, I saw that the members of the creationist study group could be flexible in their beliefs when gathering privately, although in public appearances and public statements they tended to close ranks in defending their orthodoxy.

One evening we viewed a creationist film about hominid fossils. Its narrator discussed the Piltdown Man and Nebraska Man hoaxes to make the point that evolutionary assumptions lead to foolish mistakes. He also compared the teeth and jaws of a young girl with those of a chimpanzee to suggest that it was easy to overemphasize superficial similarities and overlook important differences. The movie concluded with the idea that anatomical similarities between species should be interpreted as functional similarities designed by God, not as evolutionary links from common ancestry.

After the film, one of the leaders turned to me, saying, "Chris, you're an anthropologist. You probably know these fossils better than we do. Maybe you can tell us what weaknesses the film had that we didn't notice because we're creationists." As tactfully as I could, I replied that this film, like much creationists literature, described differences between hominid fossils in terms of two extreme polarities, labeling them either as obvious apes or as modern humans, with nothing transitional in between. However, I went on, there is a credible continuum of fossil features between the apelike early australopithecines and the recent Cro-Magnons.

One of the creationists responded that he'd heard that Neanderthal skulls fit within the range of modern human variation, and asked if this were true. "The largest and most rugged modern human skulls," I replied, "are probably Eskimo skulls. Neanderthal skulls are probably more rugged than those." At that point another of the creationists, a veterinarian, commented that if Neanderthals were within the modern human range, as creationists say, even if at the end of the range adjacent to Eskimos, the creationist scientists ought to be able to find some Neanderthals in the world's population today. None of us knew what to say to that.

Next, I was asked my opinion about studies of chimpanzee communication. "They show chimps are very clever," I responded, "but they don't prove chimps have human language capacities or that chimp communication is a prototype of human language." I added that many anthropologists are less skeptical than I am about this. The veterinarian observed that many animals are clever, but that this does not prove evolution. He then went on to emphasize how intelligent some animals are, telling us of his familiarity with animals and his concerns about animal welfare in research labs. He almost seemed on the brink of acknowledging a continuum between humans and animals. Suddenly, however, he switched to a rambling tirade about how evolutionists do not want to admit that they're living in sin.

Now the discussion had come full circle, back to hearty denunciations of evolution. A doctor remarked, "I've studied Darwin and the other evolutionists carefully, and I've found that there's nothing in it worth believing. Sure, the peppered moths changed, but that's just genetic variation, not evolution."

At this point, the meeting came to its logical end. To my surprise, I was invited to lead the closing prayer. I thought to say no, I'm the anthropologist, the observer, the evolutionist, the guy you don't really want to lead you in prayer. But I saw that they were showing appreciation for my words about fossils and chimps, or at least their honesty, if not their substance. This meant that the creationists' discussions in response to my comments had been good, that I hadn't derailed the meeting.

I stifled my instinct, as a Catholic, to blurt out a Hail Mary—not the kind of prayer I had been invited to lead. In my mind I reviewed the common pattern of evangelical prayer—I had heard many hundreds over the previous years—and began in a calm, clear voice:

> God our Father, as we gather here tonight in your heavenly presence, we're really glad to be able to come together again to study the wonders of your Creation, and to share fellowship with each other for this purpose. We're happy that these folks have been able to be here tonight. We don't always understand what you mean in the Creation you've given us, and we don't always agree about it. But we're thankful for this wonderful gift you've given us. We say this in Jesus' name. Amen.

When I got home that night, I wondered whether by leading the prayer I had in some way deceived these creationists about my work or my beliefs. I had told them many times that I was not a creationist and was not trying to pose as one. When pressed about my personal views on evolution and science, I'd say that I was a Catholic, that I got my faith and morals from revelation and inspiration, not from biology or geology or anthropology. To me, I would explain, evolution is an empirical fact, not a spiritual truth; I do not search it for God or godliness.

But since I seldom volunteered my own views at the group's meetings, and did not argue against creationism, they might have thought I agreed with their creationist beliefs, or was drifting toward them. With this in mind, I was concerned that saying the prayer could have added to that impression. But I needn't have worried. Following that evening, they took to introducing me to other creationists by saying, "This is Chris Toumey. He's an evolutionist, but he's our friend." ☐

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The Struggle for the Schools

Despite a 1987 rebuff from the Supreme Court, creationists are still pushing for equal time in science classes

by Eugenie C. Scott

Late last year, a letter received at the National Center for Science Education from one of our Alaskan members reminded me that even though some things change in the creation–evolution conflict, old battles continue. My job is to help teachers teach evolution when they are pressured not to, and to help people cope with attempts to insert the biblical story of the Creation into science classes. The letter alerted me that the Alaska State Board of Education was debating a requirement that teachers give creationism equal status alongside evolution in science classes, even though the Supreme Court outlawed such "equal time" provisions in 1987. In Alaska, as usually happens when such attempts are made to legally enforce creationism, cooler heads prevailed and the requirement was not added to the guidelines. But more frequently, I am confronted by evolved forms of creationism designed to sidestep the legal prohibitions.

By the turn of the twentieth century, evolutionary theory had captivated the world of science and had even begun to take hold in American textbooks. Some citizens, distressed at these developments, lobbied for legislation against the teaching of evolution in the public schools. John Scopes was convicted under Tennessee's antievolution law in 1925, in the so-called Monkey Trial. Although the Supreme Court struck down such laws in 1968, antievolutionists have never given up the struggle.

Antievolutionism in America is largely the creature of a Christian fundamentalist theology that was built upon five core beliefs, called "the Fundamentals," which had crystallized by about 1915. The first of these argued that the Bible should be read literally, not interpreted. The Bible said not only that God created the universe, but also how—all at one time, over six 24-hour days, and only a few thousand years ago. Evolution contradicted the biblical account of the Creation by proposing that the universe came into being over a vast period of time, and that living forms descended with modification from earlier ones. Most Catholic and Protestant clergy, while stressing the ultimate creative role of the Deity, were willing to leave the details to science, but fundamentalists rejected any such compromise.

Fundamentalists did not oppose evolution just because they believed it contradicted God's Word. After all, so did spherical-earth geology and heliocentrism; but by the early twentieth century, few Christians interpreted the Bible literally on those issues. The evidence of science on the shape and location of the earth is also accepted by most creationists today, although some still argue that the earth is the center of the solar system.

But turn-of-the-century fundamentalists were convinced, as are their modern descendants, that acceptance of evolution breeds not only theological problems but also moral ones. The most influential creationist of this century, Henry M. Morris, has blamed evolutionary theory for "communism, fascism, Freudianism, social Darwinism, behaviorism, Kinseyism, materialism, atheism, and, in the religious world, modernism and neo-orthodoxy." The worry is that if children learn evolution they will reject God. Lacking faith, children may accept "nature red in tooth and claw" as the only morality and fall into evil ways. Believers in evolution, according to Morris, will be lost to salvation and face eternal damnation.

After 1968, when the attempt to exclude evolutionary teaching from the public schools was outlawed by a decision of the Supreme Court (*Epperson* v. *Arkansas*), creationists sought equal time for their own views. Since the teaching of religious beliefs would violate the constitutional separation of church and state, creationists repackaged the Bible as science to give it a legitimate position in the curriculum. The result was the birth of "scientific creationism," the idea that scientific data exist to document the sudden creation of the universe in the not-too-distant past.

Overwhelmingly, scientists who have analyzed these arguments have concluded that creation science misstates evolutionary theory, presents erroneous data, and reveals a gross misunderstanding of the nature of science (*see* "The Flood of Antievolutionism," by Laurie R. Godfrey, *Natural History,* June 1981). But during the 1970s, several organizations, the largest being Morris's Institute for Creation Research, in California, and the Bible-Science Association, in Minnesota, successfully promoted the idea that creationism and evolution should be taught side by side in science classes as "two models" or "two theories." Their appeal for fairness won creation scientists more support than their science.

By the late 1970s, at least twenty-six state legislatures were considering "equal time" laws. Two states, Arkansas and Louisiana, passed such legislation, and both laws were immediately challenged in the courts and struck down. In 1987, the Louisiana case reached the Supreme Court, which proclaimed in *Edwards* v. *Aguillard* that creationism is inherently a religious idea. Its teaching thus represents a state advocacy of religion, violating the establishment clause of the first amendment to the Constitution.

Since 1987, the attempts to give equal time to creation science have dwindled, al-

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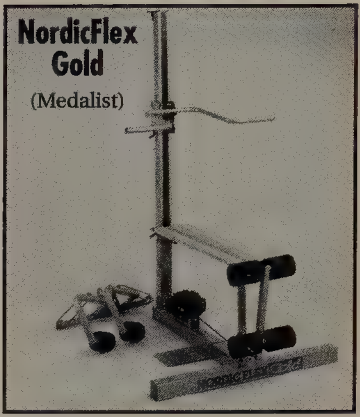
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though they still occur. For example, a school district in Vermont passed a resolution in late 1992 that "creation be presented as a viable theory on an equal status with the various theories of evolution." Once shown to school district lawyers, such resolutions are usually rescinded.

But the Supreme Court decision left a loophole that encouraged creationists to persevere. In *Edwards,* the court recognized that teachers are free to teach "all scientific theories about the origins of humankind." Justice Brennan wrote that "teaching a variety of scientific theories about the origins of humankind to schoolchildren might validly be done with the clear secular intent of enhancing the effectiveness of science instruction." This suggested that alternative theories could be taught, but it ignored that there are no reputable alternatives to evolution as a *scientific* explanation. Antievolutionists were further encouraged by Justice Antonin Scalia's dissenting opinion, when he stated that residents of Louisiana had a right "as a secular matter, to have whatever scientific evidence there may be against evolution presented in their schools."

Antievolutionists thus adopted a new strategy: avoiding Creation, Creator, or any term that implied creationism, they called for equal time to teach that evolution did not occur. This new language appeared quite soon after the *Edwards* decision, in the Texas textbook guidelines for 1990. The Texas Educational Agency told publishers that books submitted for adoption should discuss "scientific evidence of evolution and reliable scientific theories to the contrary." This language also cropped up in August 1991 in Louisville, Ohio, where a school board's science curriculum stated that teachers should "develop an appreciation of theories on evolution and its alternatives." Teachers were supposed to "contrast, compare and discuss alternatives to evolutionary theory."

In May of 1993, the school board in Vista, California, presented a resolution stating that "weaknesses that substantially challenge theories in evolution should be presented." And in December, the Tangipahoa Parish (Louisiana) school board, quoting from the *Edwards* decision itself, drafted a policy that would allow the teaching of "other theories of the origin of man" besides evolution "if done with the clear secular intent of enhancing the effectiveness of science instruction."

The "weaknesses in evolution" and "evidence against evolution" that have been put forward include such arguments as: there are no transitional forms; life is so improbable that it could not have originated "randomly"; the second law of thermodynamics (which refers to a tendency toward increased disorder) disproves evolution; radiometric dating is invalid and the earth is young. On examination these views turn out to be identical to what in pre-*Edwards* days was called scientific creationism. But the lack of obvious religious content and purpose may help insulate these antievolution arguments from legal challenge. A judge might decide that regardless of scholarly merit, these teachings did not obviously promote religion. Just because the first amendment protects against the government establishment of religion doesn't mean it will be a protection against bad science.

So far this strategy seems to have failed, at least in the cases that have been brought to the attention of the National Center for Science Education. This is partly because we are often able to offer information or other assistance to the local opposition, including finding scientists to testify on behalf of evolution and against creationism. For example, in the Vista, California, case, members of a citizens' group testified vociferously at several school board meetings that they wanted evolution, not creationism, taught and threatened to sue if the board pushed the issue. Similarly, in Tangipahoa Parish, Louisiana, scientists from the local state university and others protested at school board meetings, as well as in such public forums as "letters to the editor" columns and radio talk shows, against the teaching of "other theories" besides evolution. In March 1994 the board gave up its plan.

Students in Texas and elsewhere are not now reading science textbooks that present "scientific" theories that contradict evolution because members of our organization and others, such as People for the American Way, helped promote a change in the final wording of Texas's very influential guidelines. The curriculum now calls for adopting textbooks that provide "scientific evidence of evolution and reliable scientific theories to the contrary, if any." The "if any" allows the textbook publishers some wiggle room—they can argue that they cannot find any such theories. And the Louisville, Ohio, situation is currently on hold while the district awaits the release of a state curriculum. Protest from community members and a threatened lawsuit by the Ohio chapter of the American Civil Liberties Union probably encouraged this delay.

The evolution of creationism has taken another turn, however. In 1989, the Foundation for Thought and Ethics, a Texas-based creationist organization, published *Of Pandas and People* as a supplement to high-school biology texts. *Pandas* claims to be a balanced treatment of evolution and "intelligent design theory." In familiar creationist fashion, it presents evolution as a largely chance process that cannot account for the impressive complexity of such intricate structures as the vertebrate eye. The alternative to this allegedly random process is "intelligent design," a term that obviously suggests divine creation, although the authors deny that the intelligence is necessarily supernatural. All in all, the text parades the usual creationist arguments, only without identifying them as such.

The publisher promotes *Pandas* through a grass-roots campaign, encouraging parents to approach school curriculum committees to adopt the book. According to the publisher, *Pandas* is being used in more than forty states, although in which states and in which districts is not made clear. The book was submitted for state adoption in Idaho and Alabama and rejected in both places. A creationist school board member in Vista, California, asked teachers there to consider it as a supplementary textbook. Armed with reviews prepared by our scientists and educators, they, too, soundly rejected it. Despite these successes, however, individual teachers may be using the book. In a case in northern California, the colleagues of one teacher directed him to return the classroom copies he had ordered for his students, on the grounds that the book had not passed normal district review.

Compared with those of other industrialized nations, the American public school system is very decentralized. Local school districts make the majority of curriculum decisions, sometimes guided by state curricula but not always bound by law to obey them. State agencies may influence school districts by requiring them to spend state funds only on approved books, but what is taught in the classroom will vary locally. Not only the local school board but also the individual teacher has considerable leeway. Unless students report on what happens when the door is closed, no one else may know.

In Stanwood, Washington, for example, local residents didn't know, until a student mentioned it to a parent, that a creation scientist had been invited to lecture on the "latest scientific findings" about how humans and dinosaurs lived at the same time. In another Washington community, a teacher who was teamed up with another for a high-school science class was astounded to hear his colleague advocating the creationist view that the earth was very young. Until the two shared the same classroom, no one had known that this teacher presented creation science.

From kindergarten through high school, public school teachers face pressure to teach creation science or "evidence against evolution," or at least to downplay evolution. Our caseload at the National Center for Science Education has been steadily increasing over the last six years. Part of this increase has been brought about by a shift in American politics. The religious right, disappointed by its lack of success on the national level, has focused on winning local elective offices, including representation on school boards and curriculum committees.

When the religious right wins a majority of seats on a school board, as in Vista, California, the teaching of evolution becomes a contentious issue. Even if not forced to do so, some teachers just quietly stop teaching it. Others feel a chilling effect. One teacher wrote me that he makes sure to collect all the handouts when he teaches evolution so that parents won't know what he is teaching. That teachers have to sneak good science into the classroom is regrettable. Unfortunately, in the face of parental pressure, principals and superintendents frequently fail to support teachers, even when the curriculum mandates the teaching of evolution.

If public school teachers shrink from teaching evolution, many students will not learn about it unless they go to college—if then. Others will be deprived of one of the great enriching ideas of science. If, as the geneticist Theodosius Dobzhansky said, "Nothing in biology makes sense except in the light of evolution," these students will learn nonsensical biology, a "pile of sundry facts" unconnected by an organizing theory. □

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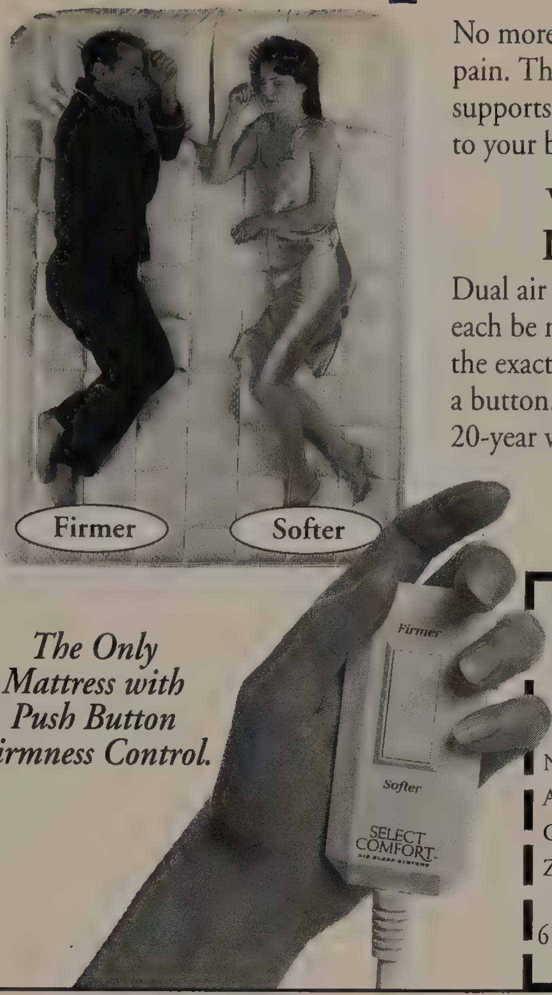

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The Monster's Human Nature

When filmmakers adapt books for the screen, they often dumb down the subtle themes

by Stephen Jay Gould

An old Latin proverb tells us to "beware the man of one book"—*cave ab homine unius libri*. Yet Hollywood knows only one theme in making monster movies, from the archetypal *Frankenstein* of 1931 to last summer's megahit, *Jurassic Park*. Human technology must not go beyond an intended order decreed by God or set by nature's laws. No matter how benevolent the purposes of the transgressor, such cosmic arrogance can only lead to killer tomatoes, very large rabbits with sharp teeth, giant ants in the Los Angeles sewers, or even larger blobs that swallow entire cities. Yet these films often use far more subtle books as their sources and, in so doing, distort the originals beyond all thematic recognition.

The trend began in 1931 with *Frankenstein,* Hollywood's first great monster "talkie" (although Boris Karloff only grunted, while Colin Clive, as Henry Frankenstein, emoted). Hollywood decreed its chosen theme by the most "upfront" of all conceivable strategies. The film begins with a prologue (even before the titles roll), featuring a well-dressed man standing on stage before a curtain, to issue both a warning about potential fright and to announce the film's deeper theme as the story of "a man of science who sought to create a man after his own image without reckoning upon God."

In the movie, Dr. Waldman, Henry's old medical school professor, speaks of his pupil's "insane ambition to create life," a diagnosis supported by Frankenstein's own feverish words of enthusiasm: "I created it. I made it with my own hands from the bodies I took from graves, from the gallows, from anywhere."

The best of a cartload of sequels, *The Bride of Frankenstein* (1935) makes the favored theme even more explicit in a prologue featuring Mary Wollstonecraft Shelley (who wrote *Frankenstein* when she was only nineteen years old and published the story two years later in 1818). In conversation with her husband, Percy, and their buddy Lord Byron, she states: "My purpose was to write a moral lesson of the punishment that befell a mortal man who dared to emulate God."

Shelley's *Frankenstein* is a rich book of many themes, but I can find little therein to support the Hollywood reading. The text is neither a diatribe on the dangers of technology nor a warning about overextended ambition against a natural order. We find no passages about disobeying God—an unlikely subject for Mary Shelley and her free-thinking friends (Percy had been expelled from Oxford in 1811 for publishing a defense of atheism). Victor Frankenstein (I do not know why Hollywood changed him to Henry) is guilty of a great moral failing, as we shall see later, but his crime is not technological transgression against a natural or divine order.

We can find a few passages about the awesome power of science, but these words are not negative. Professor Waldman, a sympathetic character in the book, states, for example:

> They [scientists] penetrate into the recesses of nature, and show how she works in her hiding places. They ascend into the heavens; they have discovered how the blood circulates, and the nature of the air we breathe. They have acquired new and almost unlimited powers.

We do learn that ardor without compassion or moral consideration can lead to trouble, but Shelley applies this argument to any endeavor, not especially to scientific discovery (her examples are, in fact, all political). Victor Frankenstein says:

> A human being in perfection ought always to preserve a calm and peaceful mind, and never to allow passion or a transitory desire to disturb his tranquillity. I do not think that the pursuit of knowledge is an exception to this rule. If the study to which you apply yourself has a tendency to weaken your affections...then that study is certainly unlawful, that is to say, not befitting the human mind. If this rule were always observed...Greece had not been enslaved; Caesar would have spared his country; America would have been discovered more gradually, and the empires of Mexico and Peru had not been destroyed.

Victor's own motivations are entirely idealistic: "I thought, that if I could bestow animation upon lifeless matter, I might in process of time (although I now found it impossible) renew life where death had apparently devoted the body to corruption." Finally, as Victor expires in the Arctic, he makes his most forceful statement on the dangers of scientific ambition, but he only berates himself and his own failures, while stating that others might well succeed. Victor says his dying words to the ship's captain who found him on the polar ice:

> Farewell, Walton! Seek happiness in tranquillity, and avoid ambition, even if it be only the apparently innocent one of distinguishing yourself in science and discoveries. Yet why do I say this? I have myself been blasted in these hopes, yet another may succeed.

But Hollywood dumbed these subtleties down to the easy formula—"man must not go beyond what God and nature intended" (you almost have to use the old gender-biased language for such a simplistic archaicism)—and has been treading in its own footsteps ever since. The latest incarnation, *Jurassic Park,* substitutes a *Velociraptor,* re-created from old DNA, for Karloff, cobbled together from bits and pieces of corpses, but hardly alters the argument an iota. Spielberg's *Jurassic Park* also dumbs down Michael Crichton's

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book version, just as James Whale demoted Shelley.

Ian Malcolm, a mathematical specialist in chaos theory, acts as the key moral critic in both book and film. In the book, he makes an intellectually interesting argument fully consistent with his specialty: visitors to the park must be protected from rapacious dinosaurs, but a safety system, so complex and so dependent upon hundreds of integrated parts and procedures, all working exactly as anticipated every single time, must eventually fail—and the collapse must be both unpredictable and spectacular.

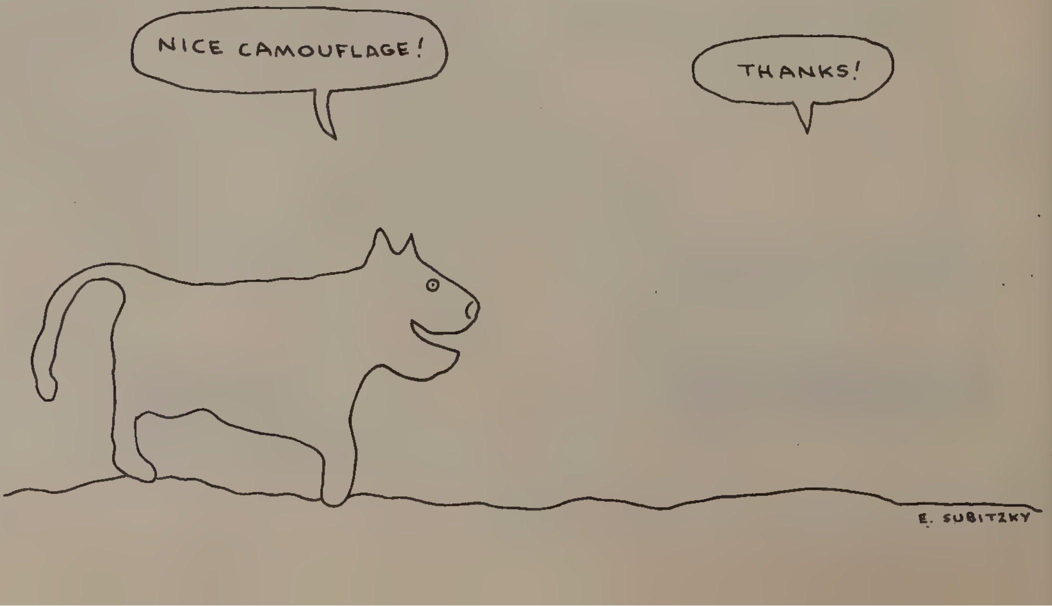
I do not find this argument too complex for popular culture. Moreover, the genre of science fiction maintains a tradition for playing with intellectual themes not often treated elsewhere—and this practice has been extended to films of great commercial success, as in the truly challenging *2001* and even in the mass marketed *Star Trek* or *Star Wars* series. Why couldn't Spielberg and company (including Crichton, who participated in the dumbdowning of his own book for the screen) have maintained Malcolm's character and argument in the film of *Jurassic Park*?

But Jeff Goldblum, as the movie's Ian Malcolm, completely perverts and overturns his own proclaimed status as a "chaotician" by invoking the tired old cliché of monster films: "man must not go beyond. . . ." He states to John Hammond, the park's creator: "Your lack of humility before nature staggers me." Hammond then counters Malcolm's opposition to bringing back extinct species from their preserved DNA by asking whether the mathematician would object to such a reconstitution of the California condor, should the last few individuals of the magnificent bird die. Malcolm replies that he would not protest such a project because the extinction would have occurred "unnaturally" as a result of human malfeasance. Why, then, object to dinosaurs? Hammond asks. Malcolm now cites the catechistic cliché: "Dinosaurs had their shot and nature selected them for extinction." In other words, the death of dinosaurs, as an event of nature's broad and intended order, as part of life's predictable and sensible development, must be honored and left untroubled, while a technologically imposed blip upon nature's pattern, like the extinction of condors, must be undone.

But such an argument emasculates chaos theory, Malcolm's stated guide to every interpretation. Chaos theory tells us that we cannot predict a sensible unrolling of life's history or state that any given event, like the extinction of dinosaurs, possessed an inevitability beyond alternative construction or present challenge. (I would also like to know why Spielberg's dinosaurs, as intended rulers of a former world less advanced than our own, can beat any mammal in Jurassic Park, including *Homo sapiens*.)

This fatal inconsistency destroys Malcolm's intellectual character. In the film's silliest and most embarrassing scene, chaos theory has no remaining clout beyond a crude invocation during a bumbling and unsuccessful seduction scene—as Goldblum's Malcolm drips water on Laura Dern's knuckles and tells her that chaos theory permits no prediction about the direction of roll, down to the fingertips or toward the wrist (of course, you have to hold your subject's hand as you illustrate this point). I suspect that Spielberg recognized the impotence thus imposed upon Malcolm, for he breaks the mathematician's leg and mercifully puts him out of further action soon thereafter.

But Karloff's *Frankenstein* contains an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even more serious and equally prominent distortion of a theme that I regard as the primary lesson of Mary Shelley's book—another lamentable example of Hollywood's sense that the American public cannot tolerate even the slightest exercise in intellectual complexity. Why is the monster evil? Shelley provides a nuanced and subtle answer that, to me, sets the central theme of her book. But Hollywood opted for a simplistic solution, so precisely opposite to Shelley's intent that the movie can no longer claim to be telling a moral fable (despite the protestations of the man in front of the curtain, or of Mary Shelley herself in the sequel) and becomes instead, as I suppose the maker intended all along, a pure horror film.

James Whale, director of the 1931 *Frankenstein,* devoted the movie's long and striking opening scenes to this inversion of Shelley's intent—so the filmmakers obviously viewed this alteration as crucial. The movie opens with a burial at a graveyard. After the mourners depart, Henry and his obedient servant, the evil, hunchbacked Fritz, dig up the body and cart it away. Then they cut down another dead man from the gallows, but Henry exclaims, "The neck's broken. The brain is useless; we must find another brain."

The scene switches to Goldstadt Medical College. Professor Waldman is lecturing on cranial anatomy and comparing "one of the most perfect specimens of the normal brain" with "the abnormal brain of a typical criminal." Waldman firmly locates the criminal's depravity in the inherited malformations of his brain; anatomy is destiny. Note; Waldman says,

> the scarcity of convolutions on the frontal lobes and the distinct degeneration of the middle frontal lobes. All of these degenerate characteristics check amazingly with the case history of the dead man before us, whose life was one of brutality, of violence, and of murder.

Fritz breaks in after the students leave and steals the normal brain, but the sound of a gong startles him and he drops the precious object, shattering its container. Fritz then has to take the criminal brain instead, but he never tells Henry. The monster is evil because Henry unwittingly makes him of evil stuff. Later in the film, Henry expresses his puzzlement at the monster's nasty temperament, for he made his creature of the best materials. But Waldman, finally realizing the source of the monster's behavior, tells Henry: "The brain that was stolen from my laboratory was a criminal brain." Henry then coun-

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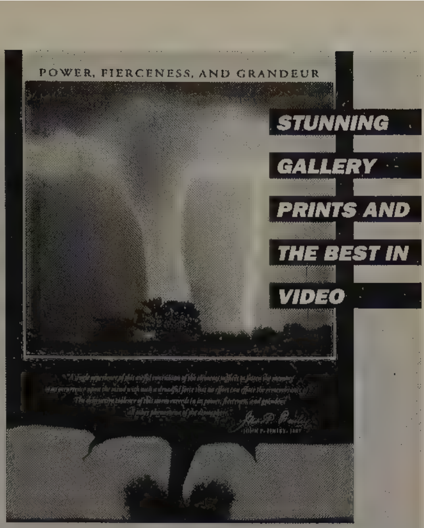

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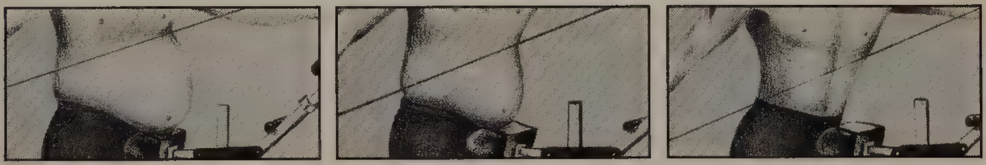

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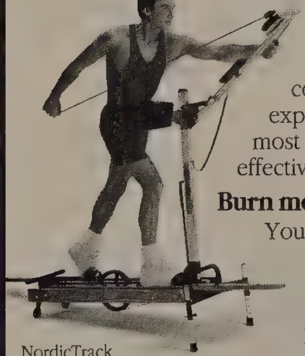

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ters with one of the cinema's greatest double takes, and finally manages a feeble retort, "Oh well, after all, it's only a piece of dead tissue." "Only evil will come from it," Waldman replies, "you have created a monster and it will destroy you"—true enough, at least until the next sequel.

Karloff's intrinsically evil monster stands condemned by the same biological determinism that has so tragically and falsely restricted the lives of millions who committed no transgression besides membership in a despised race, sex, or social class. Karloff's actions record his internal state. He manages a few grunts and, in one of the sequels, even learns some words from a blind man who cannot perceive his ugliness, although the monster never gets much beyond "eat," "smoke," and "good." Shelley's monster, by contrast, is a most remarkably literate fellow. He learns French by assimilation after hiding for several months in the hovel of a noble family temporarily in straitened circumstances. His three favorite books would bring joy to the heart of any college English professor who could persuade students to read and enjoy even one: Plutarch's *Lives,* Goethe's *Sorrows of Young Werther,* and Milton's *Paradise Lost* (of which Shelley's novel is an evident parody). The original monster's thundering threat certainly packs more oomph than Karloff's pitiable grunts: "I will glut the maw of death, until it be satiated with the blood of your remaining friends."

Shelley's monster is not evil by inherent constitution. He is born unformed—carrying the predispositions of human nature, but without the specific manifestations that can only be set by upbringing and education. He is the Enlightenment's man of hope, whom learning and compassion might mold to goodness and wisdom. But he is also a victim of post-Enlightenment pessimism as the cruel rejection of his natural fellows drives him to fury and revenge. (Even as a murderer, the monster remains fastidious and purposive. Victor Frankenstein is the source of his anger, and he only kills the friends and lovers whose deaths will bring Victor the most grief; he does not, like Godzilla or the Blob, rampage through cities.)

Mary Shelley chose her words carefully to take a properly nuanced position at a fruitfully intermediate point between nature and nurture—whereas Hollywood opted for nature alone to explain the monster's evil deeds. Frankenstein's creature is not inherently good by internal construction—a benevolent theory of "nature alone," but no different in mode of explanation from Hollywood's opposite version. He is, rather, born *capable* of goodness, even with an *inclination* toward kindness, should circumstances of his upbringing call forth this favored response. In his final confession to Captain Walton, before heading north to immolate himself at the Pole, the monster says:

> My heart was fashioned to be *susceptible of love and sympathy;* and, when wrenched by misery to vice and hatred, it did not endure the violence of the change without torture, such as you cannot even imagine [my italics to note Shelley's careful phrasing in terms of potentiality or inclination, rather than determinism].

He then adds:

> Once my fancy was soothed with dreams of virtue, of fame, and of enjoyment. Once I falsely hoped to meet with beings who, pardoning my outward form, would love me for the excellent qualities which I was *capable of bringing forth* [again, my italics]. I was nourished with high thoughts of honor and devotion. But now vice has degraded me beneath the meanest animal.... When I call over the frightful catalogue of my deeds, I cannot believe that I am he whose thoughts were once filled with sublime and transcendent visions of the beauty and the majesty of goodness. But it is even so; the fallen angel becomes a malignant devil.

"I find I can think better when I stand upright."

Why, then does the monster turn to evil against an inherent inclination to goodness? Shelley gives us an interesting answer that seems almost trivial in invoking such a superficial reason, but that emerges as profound when we grasp her general theory of human nature. He becomes evil, of course, because humans reject him so violently and so unjustly. His resulting loneliness becomes unbearable. He states:

> And what was I? Of my creation and creator I was absolutely ignorant; but I knew that I possessed no money, no friends, no kind of property. I was, besides, endowed with a figure hideously deformed and loathsome.... When I looked around, I saw and heard none like me. Was I then a monster, a blot upon the earth, from which all men fled, and whom all men disowned?

But why is the monster so rejected if his feelings incline toward benevolence, and his acts to evident goodness? He certainly tries to act kindly, in helping (albeit secretly) the family in the hovel that forms his hiding place:

> I had been accustomed, during the night, to steal a part of their store for my own consumption; but when I found that in doing this I inflicted pain on the cottagers, I abstained, and satisfied myself with berries, nuts, and roots, which I gathered from a neighboring wood. I discovered also another means through which I was enabled to assist their labors. I found that the youth spent a great part of each day in collecting wood for the family fire; and, during the night, I often took his tools, the use of which I quickly discovered, and brought home firing sufficient for the consumption of several days.

Shelley tells us that all humans reject and even loathe the monster for a visceral reason of literal superficiality: his truly terrifying ugliness—a reason heartrending in its deep injustice and profound in its biological accuracy and philosophical insight about the meaning of human nature.

The monster, by Shelley's description, could scarcely have been less attractive in appearance. Victor Frankenstein describes the first sight of his creature alive:

> How can I describe my emotions at this catastrophe, or how delineate the wretch whom with such infinite pains and care I had endeavored to form? His limbs were in proportion, and I had selected his features as beautiful. Beautiful!—Great God! His yellow skin scarcely covered the work of muscles and arteries beneath; his hair was a lus-

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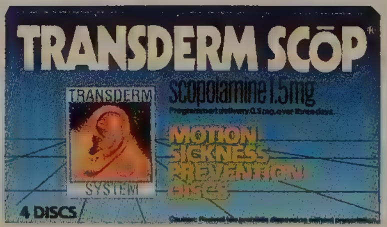

TRANSDERM SCŌP TO PREVENT MOTION SICKNESS. ASK YOUR DOCTOR.

> trous black, and flowing; his teeth of a pearly whiteness; but these luxuriances only formed a more horrid contrast with his watery eyes, that seemed almost of the same color as the dun white sockets in which they were set, his shriveled complexion, and straight black lips.

At the hyper-NBA height of eight feet, the monster scares the bejeezus out of all who cast eyes upon him.

The monster quickly grasps this unfair source of human fear and plans a strategy to overcome initial reactions and prevail by goodness of soul. He presents himself first to the blind old father in the hovel above his hiding place and makes a good impression. He hopes to win the man's confidence, and thus gain a favorable introduction to the world of sighted people. But in his joy at acceptance, he stays too long. The man's son returns and drives the monster away—as fear and loathing overwhelm any inclination to hear about inner decency.

The monster finally acknowledges his inability to overcome visceral fear at his ugliness; his resulting despair and loneliness drive him to evil deeds:

> I am malicious because I am miserable; am I not shunned and hated by all mankind?... Shall I respect man when he contemns me? Let him live with me in the interchange of kindness, and, instead of injury, I would bestow every benefit upon him with tears of gratitude at his acceptance. But that cannot be; the human senses are insurmountable barriers to our union.

Our struggle to formulate a humane and accurate idea of human nature focuses on proper positions between the false and sterile poles of nature and nurture. Pure nativism—as in the Hollywood version of the monster's depravity—leads to a cruel and inaccurate theory of biological determinism, the source of so much misery and such pervasive suppression of hope in millions belonging to unfavored races, sexes, or social classes. But pure nurturism can be just as cruel and just as wrong—as in the blame once heaped upon loving parents, in bygone days of rampant Freudianism, for failures in rearing as putative sources of mental illness or retardation that we can now identify as genetically based, for all organs, including brains, may be subject to inborn illness.

The solution, as all thoughtful people recognize, must lie in properly melding the themes of inborn predisposition and shaping through life's experiences. This fruitful joining cannot take the false form of percentages adding up to 100—as in "intelligence is 80 percent nature and 20 percent nurture," or "homosexuality is 50 percent inborn and 50 percent learned," and a hundred other harmful statements in this foolish format. When two ends of such a spectrum are commingled, the result is not a separable amalgam (like shuffling two decks of cards with different backs), but an entirely new entity that cannot be decomposed (as adults cannot be separated into maternal and paternal contributions to their totality).

The best guide to a proper integration lies in recognizing that nature supplies general ordering rules and predispositions—often strong ones to be sure—while nurture shapes specific manifestations over a wide range of potential outcomes. We make classical "category mistakes" when we attribute too much specificity to nature—as in the pop sociobiology of supposed genes for such complexly social phenomena as rape and racism; or when we view deep structures as purely social constructs—as in earlier claims that even the most general rules of grammar must be learned contingencies without any universality across cultures. Noam Chomsky's linguistic theories represent the paradigm for modern concepts of proper integration between nature and nurture—principles of universal grammar as inborn learning rules, with peculiarities of any particular language as a product of cultural circumstance and place of upbringing.

Frankenstein's creature becomes a monster because he is cruelly ensnared by one of the deepest predispositions of our biological inheritance—our aversion toward seriously malformed individuals. (Konrad Lorenz, the most famous ethologist of the last generation, based much of his theory on the primacy of this inborn rule.) We are now appalled by the injustice of such a predisposition, but this proper moral feeling is an evolutionary latecomer, imposed by human consciousness upon a much older mammalian pattern.

We almost surely inherit such an instinctive aversion to serious malformation, but remember that nature can only supply a predisposition, while culture shapes specific results. And now we can grasp—for Mary Shelley presented the issue to us so wisely—the true tragedy of Frankenstein's monster and the moral dereliction of Victor himself. The predisposition for aversion toward ugliness can be overcome by learning and understanding. I trust that we have all trained ourselves in this essential form of compas-

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CONTRAINDICATIONS
Transderm Scōp should not be used in patients with known hypersensitivity to scopolamine or any of the components of the adhesive matrix making up the therapeutic system, or in patients with glaucoma.

WARNINGS
Transderm Scōp should not be used in children and should be used with special caution in the elderly. See **PRECAUTIONS.**

Since drowsiness, disorientation, and confusion may occur with the use of scopolamine, patients should be warned of the possibility and cautioned against engaging in activities that require mental alertness, such as driving a motor vehicle or operating dangerous machinery.

Potentially alarming idiosyncratic reactions may occur with ordinary therapeutic doses of scopolamine.

PRECAUTIONS
General. Scopolamine should be used with caution in patients with pyloric obstruction, or urinary bladder neck obstruction.

Caution should be exercised when administering an antiemetic or antimuscarinic drug to patients suspected of having intestinal obstruction.

Transderm Scōp should be used with special caution in the elderly or in individuals with impaired metabolic, liver or kidney functions, because of the increased likelihood of CNS effects.

Information for Patients. Since scopolamine can cause temporary dilation of the pupils and blurred vision if it comes in contact with the eyes, patients should be strongly advised to wash their hands thoroughly with soap and water immediately after handling the patch.

Patients should be advised to remove the patch immediately and contact a physician in the unlikely event that they experience symptoms of acute narrow-angle glaucoma (pain in and reddening of the eyes accompanied by dilated pupils).

Patients should be warned against driving a motor vehicle or operating dangerous machinery. A patient brochure is available.

Drug Interactions. Scopolamine should be used with care in patients taking drugs, including alcohol, capable of causing CNS effects. Special attention should be given to drugs having anticholinergic properties, e.g., belladonna alkaloids, antihistamines (including meclizine), and antidepressants.

Carcinogenesis, Mutagenesis, Impairment of Fertility. No long-term studies in animals have been performed to evaluate carcinogenic potential. Fertility studies were performed in female rats and revealed no evidence of impaired fertility or harm to the fetus due to scopolamine hydrobromide administered by daily subcutaneous injection. In the highest dose group (plasma level approximately 500 times the level achieved in humans using a transdermal system), reduced maternal body weights were observed.

Pregnancy Category C. Teratogenic studies were performed in pregnant rats and rabbits with scopolamine hydrobromide administered by daily intravenous injection. No adverse effects were recorded in the rats. In the rabbits, the highest dose (plasma level approximately 100 times the level achieved in humans using a transdermal system) of drug administered had a marginal embryotoxic effect. Transderm Scōp should be used during pregnancy only if the anticipated benefit justifies the potential risk to the fetus.

Nursing Mothers. It is not known whether scopolamine is excreted in human milk. Because many drugs are excreted in human milk, caution should be exercised when Transderm Scōp is administered to a nursing woman.

Pediatric Use. Children are particularly susceptible to the side effects of belladonna alkaloids. Transderm Scōp should not be used in children because it is not known whether this system will release an amount of scopolamine that could produce serious adverse effects in children.

ADVERSE REACTIONS
The most frequent adverse reaction to Transderm Scōp is dryness of the mouth. This occurs in about two thirds of the people. A less frequent adverse reaction is drowsiness, which occurs in less than one sixth of the people. Transient impairment of eye accommodation, including blurred vision and dilation of the pupils, is also observed.

The following adverse reactions have also been reported on infrequent occasions during the use of Transderm Scōp: disorientation, memory disturbances; dizziness; restlessness; hallucinations; confusion; difficulty urinating; rashes and erythema; acute narrow-angle glaucoma; and dry itchy, or red eyes.

Drug Withdrawal: Symptoms including dizziness, nausea, vomiting, headache and disturbances of equilibrium have been reported in a few patients following discontinuation of the use of the Transderm Scōp system. These symptoms have occurred most often in patients who have used the systems for more than three days.

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sion; that we all work hard to suppress that *frisson* of revulsion (which in honest moments we all admit we feel) and to judge people by their qualities of soul, not by their external appearances.

Frankenstein's monster was a good man in an appallingly ugly body. His countrymen could have been educated to accept him, but the person responsible for that instruction—his creator, Victor Frankenstein—ran away from his foremost duty, and abandoned his creation at first sight. Victor's sin does not lie in misuse of technology or hubris in emulating God; we cannot find these themes in Mary Shelley's account. Victor failed because he followed a predisposition of human nature—visceral disgust at the monster's appearance—and did not undertake the duty of any creator or parent: to teach his own charge and to educate others in acceptance.

He could have schooled his creature (and not left the monster to learn language by eavesdropping and by scrounging for books in a hiding place under a hovel). He could have told the world what he had done. He could have introduced his benevolent and educated monster to people prepared to judge him on merit. But he took one look at his handiwork and ran away forever. In other words, he bowed to a base aspect of our common nature and did not accept the particular moral duty of our potential nurture:

> I had worked hard for nearly two years, for the sole purpose of infusing life into an inanimate body. For this I had deprived myself of rest and health. I had desired it with an ardor that far exceeded moderation; but now that I had finished, the beauty of the dream vanished, and breathless horror and disgust filled my heart. Unable to endure the aspect of the being I had created, I rushed out of the room.… A mummy again endued with animation could not be so hideous as that wretch. I had gazed on him while unfinished; he was ugly then; but when those muscles and joints were rendered capable of motion, it became a thing such as even Dante could not have conceived.

The very first line of the preface to *Frankenstein* has often been misinterpreted: "The event on which this fiction is founded has been supposed, by Dr. Darwin, and some of the physiological writers of Germany, as not of impossible occurrence." People suppose that "Dr. Darwin" must be Charles of evolutionary fame. But Charles Darwin was born on Lincoln's birthday in 1809 and wasn't even ten years old when Mary Shelley wrote her novel. "Dr. Darwin" is Charles's grandfather Erasmus, one of England's most famous physicians and an atheist who believed in the material basis of life. (Shelley is referring to his idea that such physical forces as electricity might be harnessed to quicken inanimate matter—for life has no inherently spiritual component and might therefore emerge from nonliving substances infused with enough energy.)

I will, however, close with my favorite moral statement from Charles Darwin, who, like Mary Shelley, also emphasized our duty to foster the favorable specificities that nurture and education can control. Mary Shelley wrote a moral tale, not about hubris or technology, but about responsibility to all creatures of feeling and to the products of one's own hand. The monster's misery arose from the moral failure of other humans, not from his own inherent and unchangeable constitution. Charles Darwin then invoked the same theory of human nature to remind us of duties to all people in universal bonds of brotherhood: "If the misery of our poor be caused not by the laws of nature, but by our institutions, great is our sin."

Stephen Jay Gould teaches biology, geology, and the history of science at Harvard University.

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Trigg Sandstone Pavement, Illinois

by Robert H. Mohlenbrock

While most of Illinois is flat—a one-time prairieland now mostly devoted to corn and soybean fields—the southern eighth of the state is much more varied. Three-hundred-foot limestone bluffs line the Mississippi River to the west and the Ohio River to the east as they roll toward their confluence at the southern tip of the state. In between is a more or less continuous outcropping of sandstone, known as the Shawnee Ridge, much of which is managed by the Shawnee National Forest. Within it are exposed sandstone surfaces up to several acres in size. I sometimes have referred to them as glades or barrens, but a better name for them is sandstone pavements.

In the Shawnee Ridge zone are 200- to 300-foot-deep ravines, locally referred to as canyons, filled with large American beeches, sugar maples, shagbark hickories, and tulip poplars. On the midslopes above the shaded canyon floors, a rather dry forest is dominated by several kinds of oaks, while the driest ridgetops support a forest of stunted, gnarly post oaks, blackjack oaks, winged elms, black hickories, and red cedars. The patches of exposed sandstone, often no more than a few feet wide, lie mainly on west- or southwest-facing ridgetops, where the full heat of the afternoon sun bears down on the rock surface. Trees have not been able to encroach on these spots because conditions are so hot and dry during the growing season.

Below: Weathered sandstone in the Shawnee Ridge. Right: A prickly pear in bloom.
Todd Fink; Daybreak Imagery

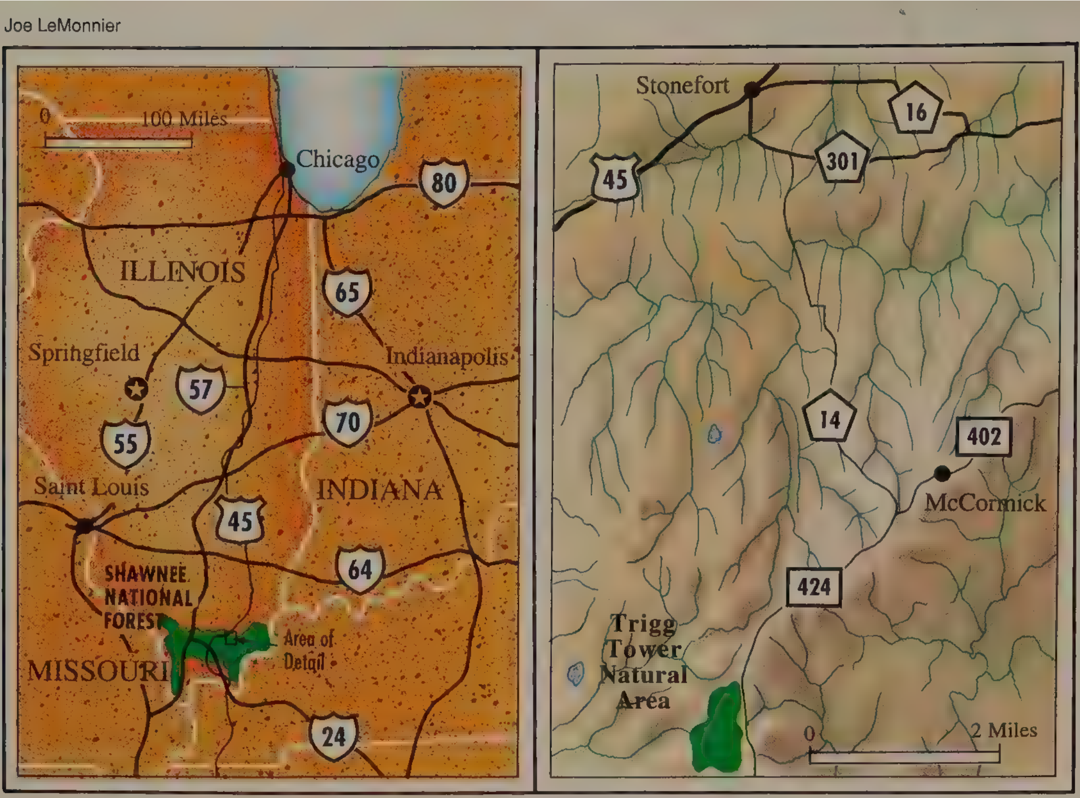
One of the most extensive and pristine bare areas is Trigg Sandstone Pavement, accessible only by a network of one-lane gravel roads. From a distance, it appears bare of vegetation, but a closer look reveals a variety of colorful lichens cemented to the rock surface, as well as mats of black moss. The lichens, and to a lesser extent the mosses, anchor themselves on the pavement by secreting an acid that etches the rock surface just enough for them to become established. After hundreds or even thousands of years, the lichens and mosses, along with the weather, have gradually eroded the sandstone, creating pockets and crevices filled with thin soil. This soil provides tiny footholds for some flowering plants and ferns that can tolerate the harsh habitat.

One afternoon last summer, when the air temperature had soared into the mid-90s, I recorded the temperature at the exposed pavement surface at 120°F (in comparison, the soil of the nearest canyon floor was only 76°F). Among the plants I found surviving this desertlike heat was a prickly pear with waxy, yellow flowers. This cactus stores lots of water in its flat, thick stems, while its leaves, reduced to hard spines, offer no surface for water loss.

Other succulent plants on the pavement have fleshy, water-storing leaves. Among them are a six-inch-tall, pink-flowered sedum known locally as widow's-cross, a small agave related to the century plants of the western United States, and a delicate plant related to portulacas called flower-of-an-hour (this plant is unrelated to the flower-of-an-hour in the hibiscus family). The three-quarter-inch-wide, pink flowers of flower-of-an-hour open about ten o'clock in the morning and begin to wither an hour later. Beginning in mid-July, one or two flowers open on the plant each day until all the flower buds have opened, usually by late August. The timing is almost accurate enough to set your watch by.

A dense covering of hairs or scales on the leaves of other plants insulates them from the direct rays of the sun and pre-

Joe LeMonnier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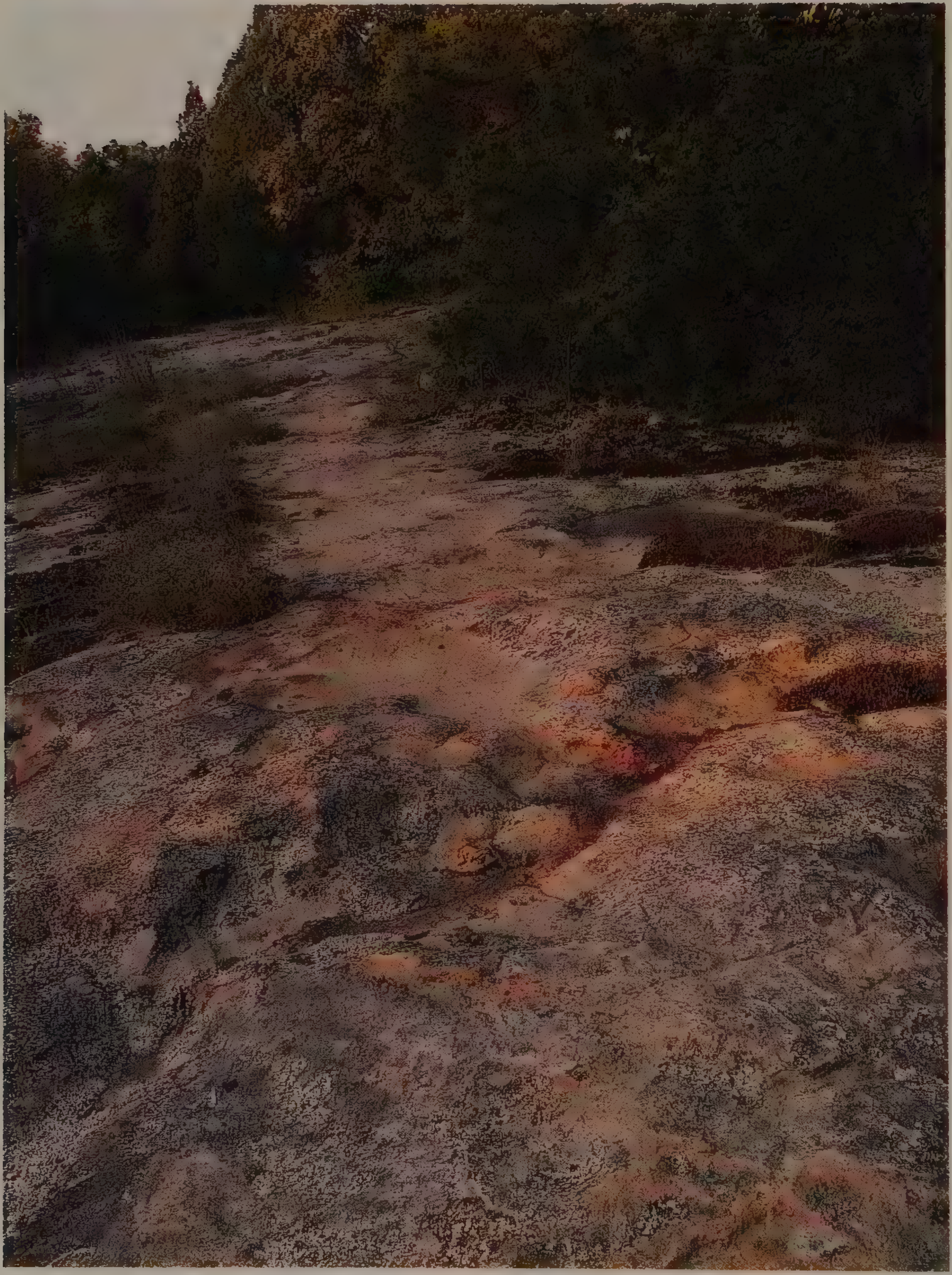
vents moisture from escaping. Lip fern, a six-inch fern with a purplish black leaf stalk, has fronds so densely covered with hairs that they hide the surface of the leaves. Another six-inch plant with hairy leaves is small croton, while an equally diminutive one whose protection consists of flat, silvery scales is rushfoil.

Several species on the sandstone pavement have tiny leaves, sometimes so reduced that they scarcely resemble leaves. These provide less surface for evaporation. Among them are a tiny evening primrose known as thread-leaved sundrop, a dwarf Saint Johnswort called pinweed, and rock club moss, which is a dwarf evergreen plant closely related to ferns.

Some of the plants send down unusually long taproots through the rocky crevices, where they may reach additional moisture. One of the most striking is pencil flower, a yellow-flowering member of the pea family. While its aboveground stem may be only six to eight inches tall, its taproot may penetrate two to four feet.

But some plants avoid the hottest, driest days on Trigg Sandstone Pavement by simply making their exit before midsummer. These are annual plants, which sprout early in the year, usually in March, and produce their full set of leaves, flowers, and fruits during April, May, and early June. They then wither away by July, relying on their seeds to repeat the cycle the following year.

Robert H. Mohlenbrock, professor emeritus of plant biology at Southern Illinois University, Carbondale, explores the biological and geological highlights of the 156 U.S. national forests.



Nearly bare of soil, Trigg Sandstone pavement supports the growth of some lichens, cactuses, and other plants that can tolerate the desertlike heat.
Kenneth Murray

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Charting the Actual and Imagined

by Yi-Fu Tuan

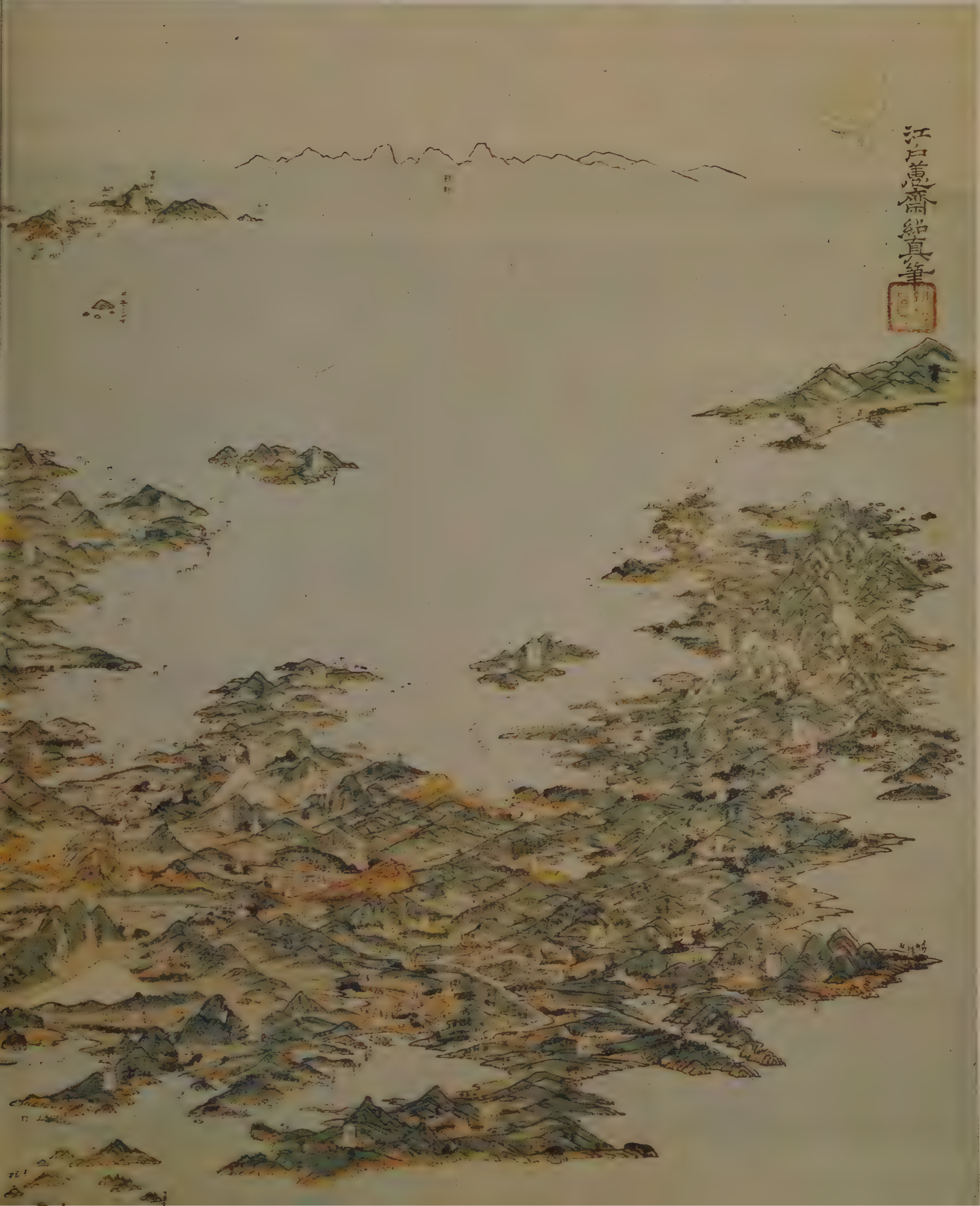
In May of 1977, geographers Brian Harley and David Woodward were strolling through the English countryside, discussing a collaboration on the mapping of North America. But as they walked and talked, they began to plan a work of even greater scope—a comprehensive history of worldwide mapping from prehistoric times to our century.

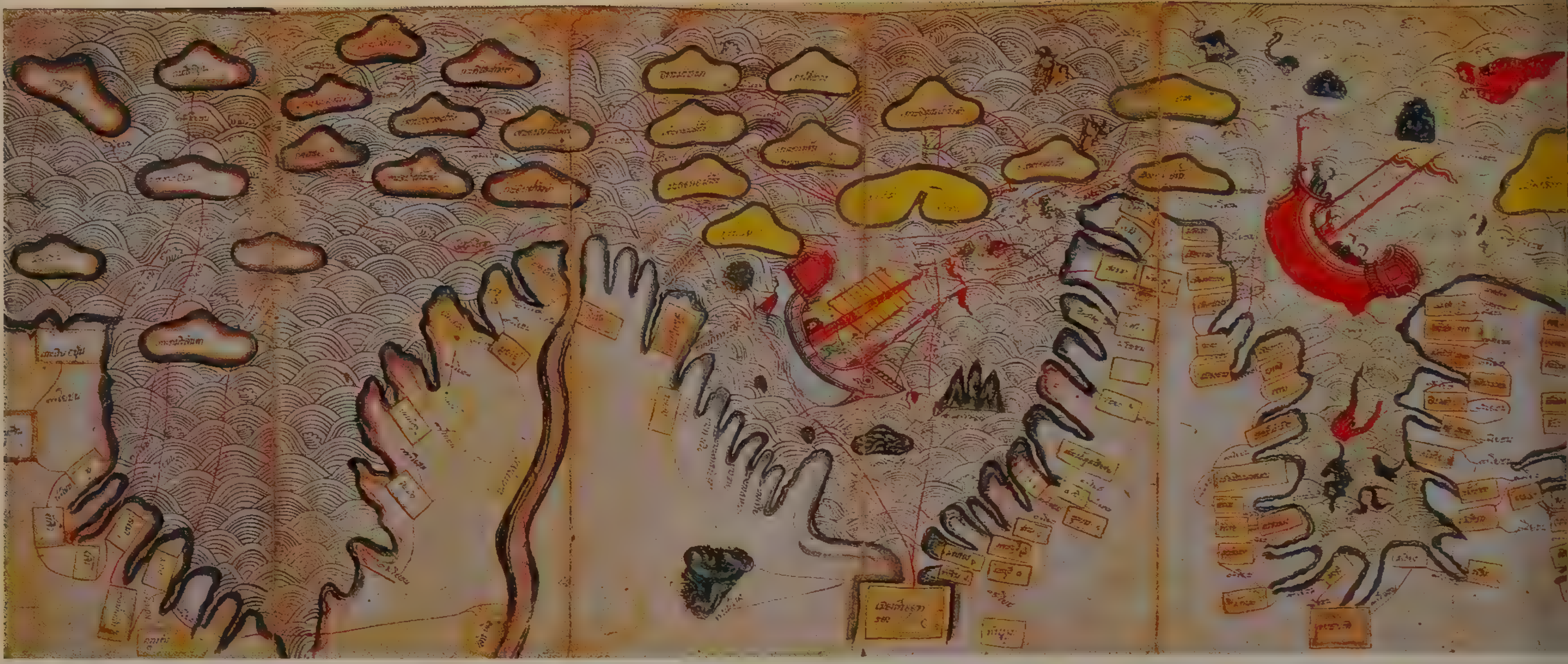
Under their joint editorship, two volumes of *The History of Cartography* are now in print, with at least four more to come. Their international team of scholars has already appraised for us an extraordinary range of cartographic artifacts, from Neolithic wall paintings to the globes, maps, and diagrams of the ancient Mediterranean and medieval European worlds to the dazzling variety of cartographic accomplishments in Islamic and Asian societies. Future volumes will include the brilliant works of the Renaissance and the Enlightenment; cartographic enterprise in the age of expansion and the nineteenth century; and the technological innovations of our time, including, no doubt, satellite and GIS (Geographical Information Systems) imagery.

THE HISTORY OF CARTOGRAPHY, edited by J. B. Harley and David Woodward, vol. 2, book 2. *University of Chicago Press, $150; 950 pp.; illus.*

What do all these artifacts have in common? More simply put, what is a map? Historians of cartography have had to choose between a narrow view, in which faithfulness to the earth's surface is of primary importance, and a liberal view, which, in contrast, regards a map as any attempt to picture the spatial qualities of the world, actual or imagined. The narrow view is heavily Western, with an emphasis on progress toward systematic measurement and precision. The liberal view emphasizes the multiplicity of styles, incommensurate as to purpose, hence not to be ranked on a uniform scale of achievement.

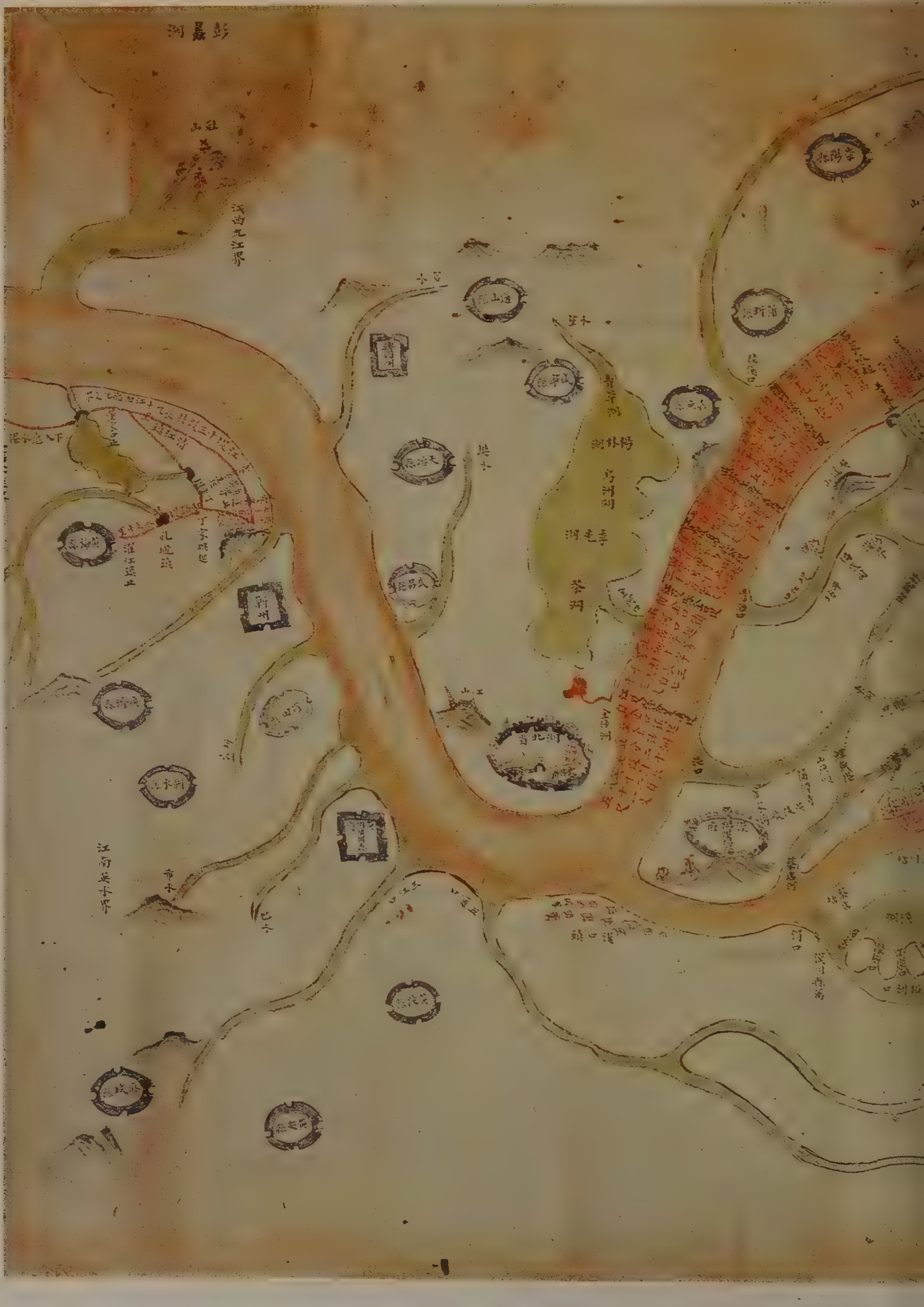
Kuwagata Keisai's 1804 woodblock print was the first aerial image of Japan.
Bibliotheek der Rijksuniversiteit, Leiden





Museum für Indische Kunst, Staatliche Museen zu Berlin

A Thai map of Asia, from the Arabian Sea to Korea and Japan, above, is dated 1176 and signed by four artists. India appears near the right border, while China dominates the left half of the map. The islands along the top depict the archipelagoes of Japan and what is now Indonesia. Right: A nineteenth-century Chinese pictorial map of the Yangtze and Han Rivers show flood control works in Hubei Province.



Unlike earlier historians of cartography, Harley and Woodward have wholeheartedly embraced the liberal view.

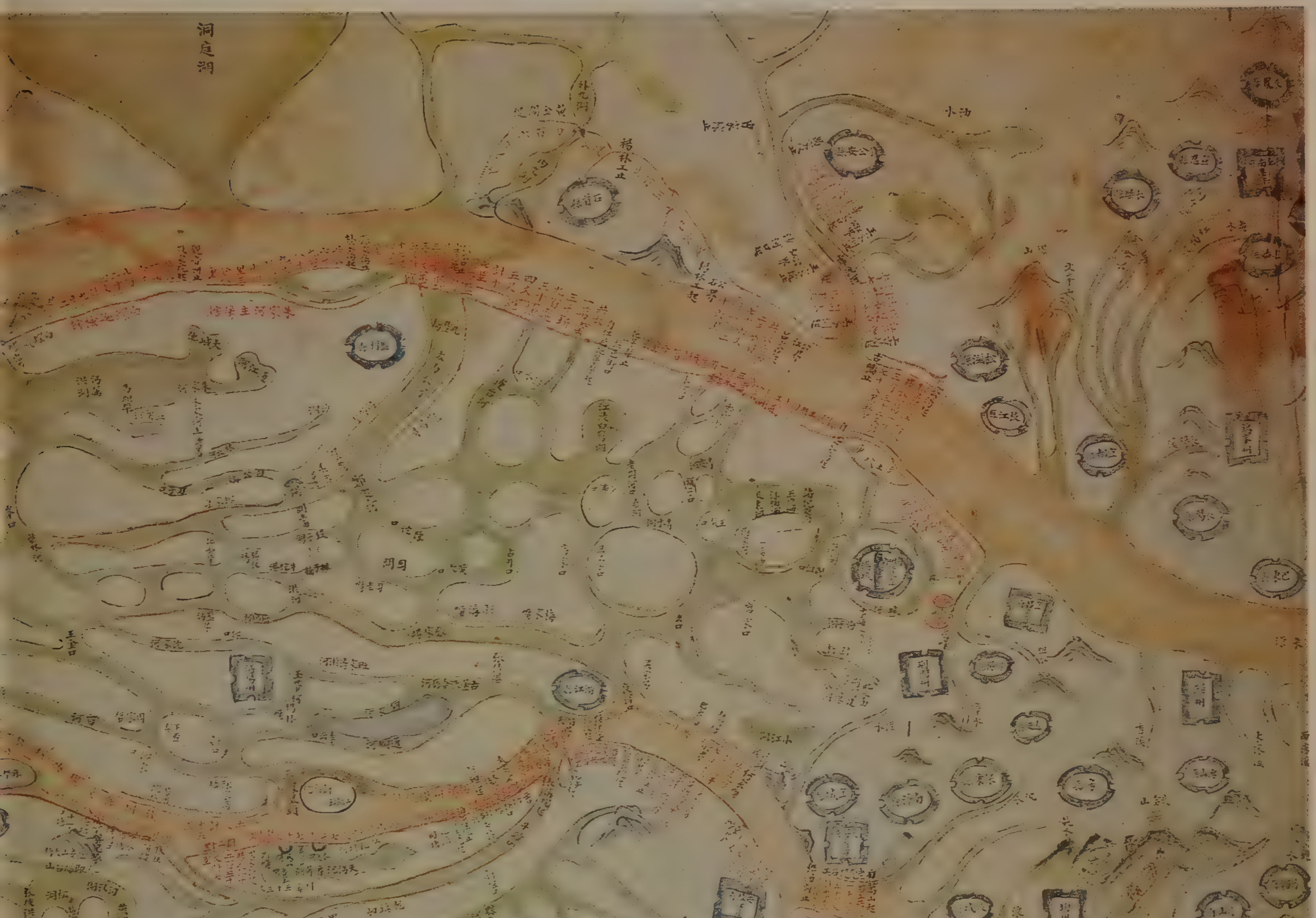
China, Korea, Japan, Tibet, and Southeast Asia are the five areas covered in this volume. Of these, Southeast Asia's cartographic artifacts are the most heterogeneous. The area as a whole can hardly be said to have a cartographic tradition. Maps, for instance, bear little similarity to one another even when they come from the same Malay world. Moreoever, parts of Southeast Asia, including the Philippines, Laos, and Cambodia, have not yielded a single premodern noncosmographic map. Writing a coherent chapter on Southeast Asian cartography is therefore a special challenge, one that its author, Joseph Schwartzberg, gallantly tries to meet.

Tibet presents another kind of challenge. A rich cartographic tradition does indeed exist there, but only if one assumes an exceptionally broad understanding of a map. The innumerable mandalas and the chortens (shrines for the housing of reliquaries) can be included in Tibet's cartographic heritage, for they may all be viewed as attempts to envisage and reproduce the Buddhist cosmos, often in a highly schematic manner. Paintings that illustrate Tibetan works of mythology and hagiography are not maps in any sense, yet they, too, furnish maplike components and scenes if one searches hard enough.

The dominant role of religion in Tibet's cultural heritage, which is a distillation of Hindu and Chinese civilizations in almost equal parts, makes the customs and artifacts of that country, including maps, highly distinctive. Mapmaking in Korea and Japan is more mainstream, being part of a large cartographic realm that has China at its historical core. However, despite strong Chinese influence, Korea and Japan have developed their own mapping traditions.

Korea's form of government became highly centralized, after the Chinese model, during the Koryo dynasty, from A.D. 918 to 1392. Such centralization necessitated detailed knowledge of local units, including the sort of information best displayed on maps. Moreover, this was a time when the Koreans, even more than the Chinese, were enamored of geomancy, or divination by means of the earth's configuration. The geomantic analysis of site and location at different scales required mapping skills. As Gari Ledyard, the author of the chapter on Korea, puts it: "During the ninth and tenth centuries the mountain paths must have been thronged with monks and geomancers searching out the secrets of the nation's arterial system." Measurement became a requirement (although clearly not the only one) as early as the fifteenth century, when a landscape artist, a mathematician-surveyor, a cartographer, and a geomancer might all cooperate to produce a good likeness of Seoul. Korea, moreover, has always been sensitive to threats by external enemies, and one way to cope with such threats, particularly during the seventeenth century, was to produce good maps. Although functional, these nevertheless were drawn to appeal to the eye.

Korea can boast the earliest world map (circa 1402) in East Asia. Its purpose would seem to have been to show the country as large and important, unlike



Geography and Map Division, Library of Congress

Japan, which is pushed to the side. China has produced a number of empire maps that, from its ethnocentric viewpoint, were world maps. Ethnocentric in its own way, Japan was too interested in itself to map the rest of the world. Maps of its own islands were abundantly drawn at different scales as early as the Nara period, from 710 to 784.

Japan, as Kazutaka Unno says in his chapter, is "a pragmatically oriented society." The vast majority of premodern maps catered to practical uses, including administration, the settling of boundary disputes, way-finding for pilgrims and, increasingly, for tourists during the Edo period from 1603 until 1867. Indeed, from 1700 onward, as more and more ordinary people could afford to travel for pleasure, they took to consulting gazetteers and buying printed maps that showed places worthy of a visit. Japanese mapmaking throughout the Edo period, although concerned foremost with use, also aspired to high aesthetic quality. Cartographers were artists, and many maps had only a decorative purpose—for instance, those that appeared on folding screens, hanging scrolls, sword guards, and plates.

I have left China until the last because of the questions raised by Cordell D. K. Yee. What is a map? And what constitutes cartographic excellence? His chapters on China have a narrative flow that the other chapters lack, in part because Yee is more successful in presenting facts within a context of general ideas and arguments. China, in its long imperial history, has produced many cartographic artifacts, including cosmographic schemata, geographical maps at scales that range from empires to local regions covered in gazetteers, and specialized hydrological and property-line surveys. Even under the narrowest definition, the noncosmographic artifacts must be considered maps.

Modern Chinese scholars, swayed by Western cartographic values, have noted how backward even some of their nineteenth-century maps are. Such maps still resort to pictorialism and show no meridians and parallels. On the other hand, the same scholars are surprised and pleased to discover how modern some very old Chinese maps look. Silk maps found in a tomb in Hunan Province, for example, date from about 150 B.C. and show the location of army installations and headquarters; color is used to distinguish different kinds of features and to provide some evidence of scale. Accuracy was at least implicitly a criterion of excellence in ancient China. Indeed, Pei Xiu, who lived in the third century A.D., advocated using measurement and scale for achieving fidelity to geographic actualities.

Given China's remarkable headstart in cartographic science, one can't help but wonder why it didn't blossom there as it did in Europe. Several reasons come to mind. One is that the earliest maps, which were placed in tombs, were icons of quasi-magical potency, not just functional devices. If true, that simply shows what people believed in more than two thousand years ago. A milder version of the same idea is that maps have power—they "command" a territory and can evoke a sense of place. But any informative and attractive map, even a gas station road map, can have this sort of power, which may well be inherent to all maps. Perhaps Chinese cartography was too intimately fused with aesthetics for it to develop separately as a science. In my view, aesthetic considerations have also been a strong historic component of Western mapmaking, yet they did not hinder it from developing into a science.

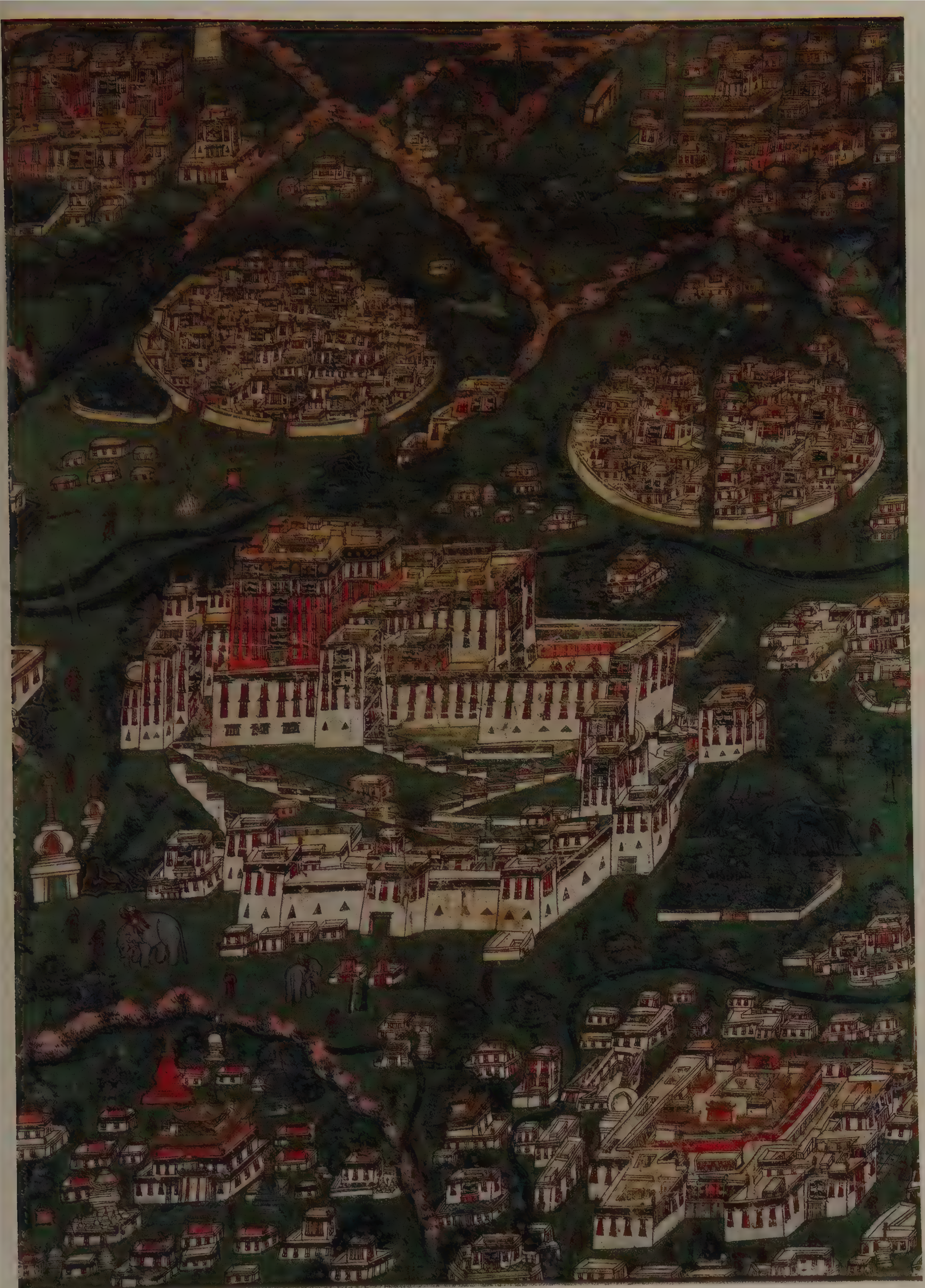
One significant difference between China and the West is the strong and persistent pictorial element in Chinese cartography. Map and landscape art (which frequently shows maplike scenes from an oblique angle) are more closely integrated in China than they are in Europe. Another difference is the Chinese emphasis on the written text. As Yee has repeatedly noted, Chinese cartographers did not feel the need to indicate accurate scale because they believed that quantitative information could be accommodated more readily in words. This textual emphasis reflects China's traditional allocation of prestige to verbal, as distinct from spatial-technical, skills. And finally, China's attitude to knowledge has always been pragmatic: there was little desire to pursue knowledge systematically for its own sake. Cartography was essentially a tool of government, a skill that all officials should have, along with other technical skills such as engineering, building and dam construction, and military strategy.

The questions I have raised are not (except for Yee's chapters) the ones *The History of Cartography,* as a whole, seeks to address. The *History*'s basic premise is that maps are different, as are cultures. Its purpose is to display the richness of artifacts, and it has done so magnificently and with exemplary thoroughness. What I miss in this authoritative work, however, is a sense of story—of theses and themes. Some chapters have almost the texture of a *catalogue raisonné,* rather than of essays that one would want to read through. Is there now a general agreement among students of cartography that maps, like other artistic creations, have no history of development? Tibetan students may well say yes, and so remove their maps from the onus of comparison. By contrast, East Asian students have accepted the values of Western cartography, even though, in doing so, they risk finding their own heritage deficient. They have embraced modern Western cartography as they have embraced modernization, because they know that only it has the power to make their countries politically and economically strong. Ironically, not Asian but Western scholars now see cartography more as works of art and culture than as works of applied knowledge that can improve over time.

The British Library, London

Painted on heavy mulberry bark paper, a Burmese cosmological map, above, is part of an illustrated, late-nineteenth-century manuscript. Right: A map of the Potala and other holy places of central Tibet, probably painted in the late eighteenth century, represents an area of several thousand square miles. The two elephants in front of the Potala were gifts from the king of Nepal to the Dalai Lama and were said to have died not long after their arrival on the high plateau.

Yi-Fu Tuan is the J. K. Wright and Vilas Professor of Geography at the University of Wisconsin-Madison. His books include: Passing Strange and Wonderful, Topophilia, Landscapes of Fear, *and* Morality and Imagination.



Réunion des Musées Nationaux, Paris

Mussels, periwinkles, barnacles, and rockweed, left, flourish in tidal pools, such as those along the rocky shoreline of Mount Desert Island, Maine, bottom.
Anne Heimann

Give Me Your Shelled, Your Clawed

The community of mollusks and crustaceans along America's North Atlantic shores is a melting pot of natives and immigrants

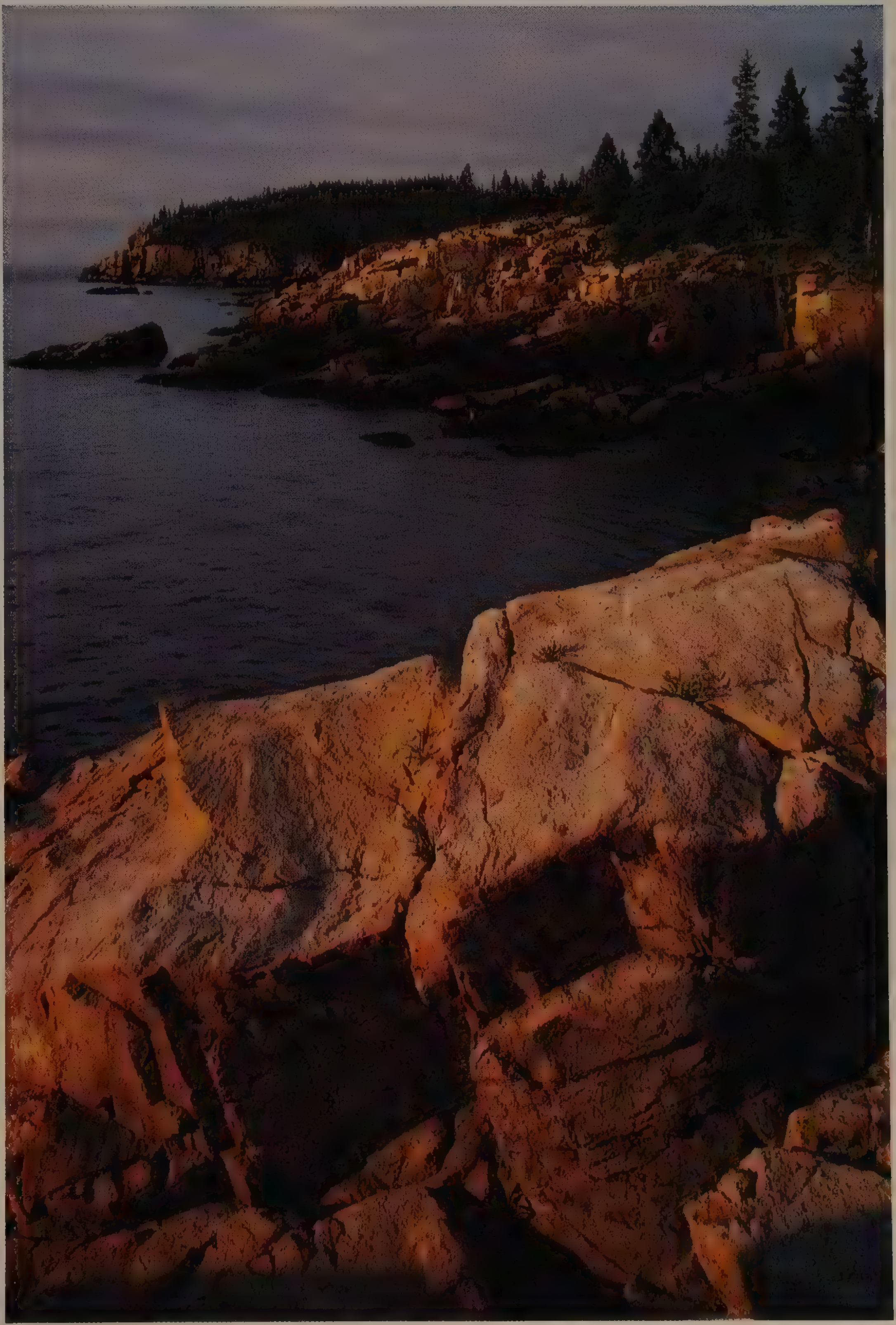
by Geerat J. Vermeij

To the New England naturalist, the tide pools on the rockbound shores of Maine and southeastern Canada present a familiar scene. While mussels and acorn barnacles are busily filtering small food particles out of the water that bathes them, periwinkles are quietly grazing the lush growth of delicate green sea lettuce. Dog whelks crawl slowly about in search of barnacles and mussels. Deeper in the pool, under a canopy of brown kelp, sea urchins scrape away encrusting plants and animals, while crabs and lobsters scuttle to places of shelter.

So familiar and unremarkable is this community that we are apt to think of it as timeless, existing in balance, if not in harmony, for ages. Yet beneath this superficial serenity lurks the ferment of history. The apparently stable community is in reality a melting pot of natives and immigrants, a "crab bag" thrown together by extraordinary events and circumstances dating from four million years ago to the present. The tale is one of invasion and extinction, and of new links being forged between species that evolved in regions as different as coastal Europe, North America, and the North Pacific.

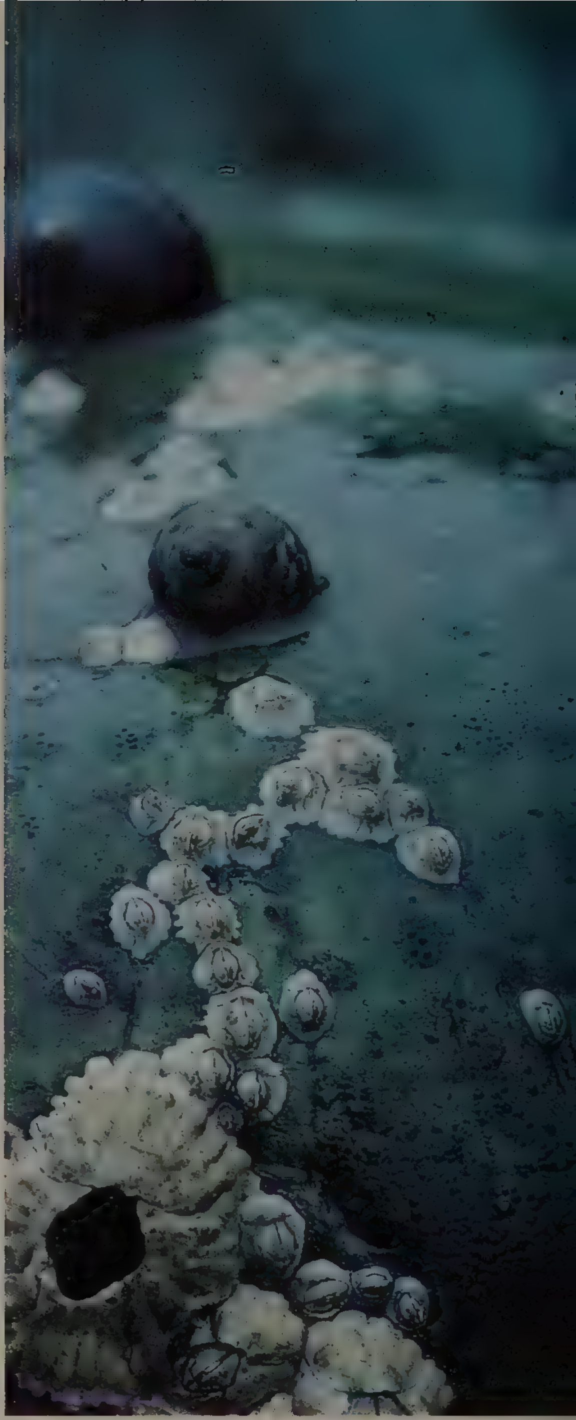
I became interested in this kind of history once I started to compare marine life from biologically distinct, but climatically similar, parts of the world. The shallow-water communities of the cold North Pacific shores, from north of Oregon in the east to Honshu, Japan, in the west, are intriguing because they harbor two to three times as many species as do those of eastern North America north of Cape Cod. Such disparities may reflect subtly different climates, but they also expose the role of history.

Why should we study the history of


Ted Levin

European green crabs, below, mate in the shallow waters of a tidal pool. As commerce between Europe and North America increased in the mid-eighteenth century, the species first appeared south of Cape Cod and eventually spread north to Nova Scotia. The dog whelk, right, migrated from the Pacific to the Atlantic about 2.4 million years ago; when the predatory green crab arrived, the whelk's shell lip thickened.

Herb Segars



communities? The simple answer is that the past is a key to the present and a possible guide to the future. In the human-dominated world of today, invasion and extinction of communities are nearly everyday phenomena that have potentially profound consequences for the humans that depend on them. By reconstructing the comings and goings of species on the geological time scale, we can begin to appreciate the longer-term consequences of changes that are sweeping the biosphere.

The detective work of reconstructing biological history involves fields as diverse as paleontology and molecular biology. Not only must we trace the genealogy of species by inferring the sequence of evolutionary branching events from the ancestral stock to the descendant lineages but we must also assign dates and places to these events. Of course, species did not evolve in a vacuum. We must therefore probe the everyday circumstances of life for species in the past as well as for those in the present.

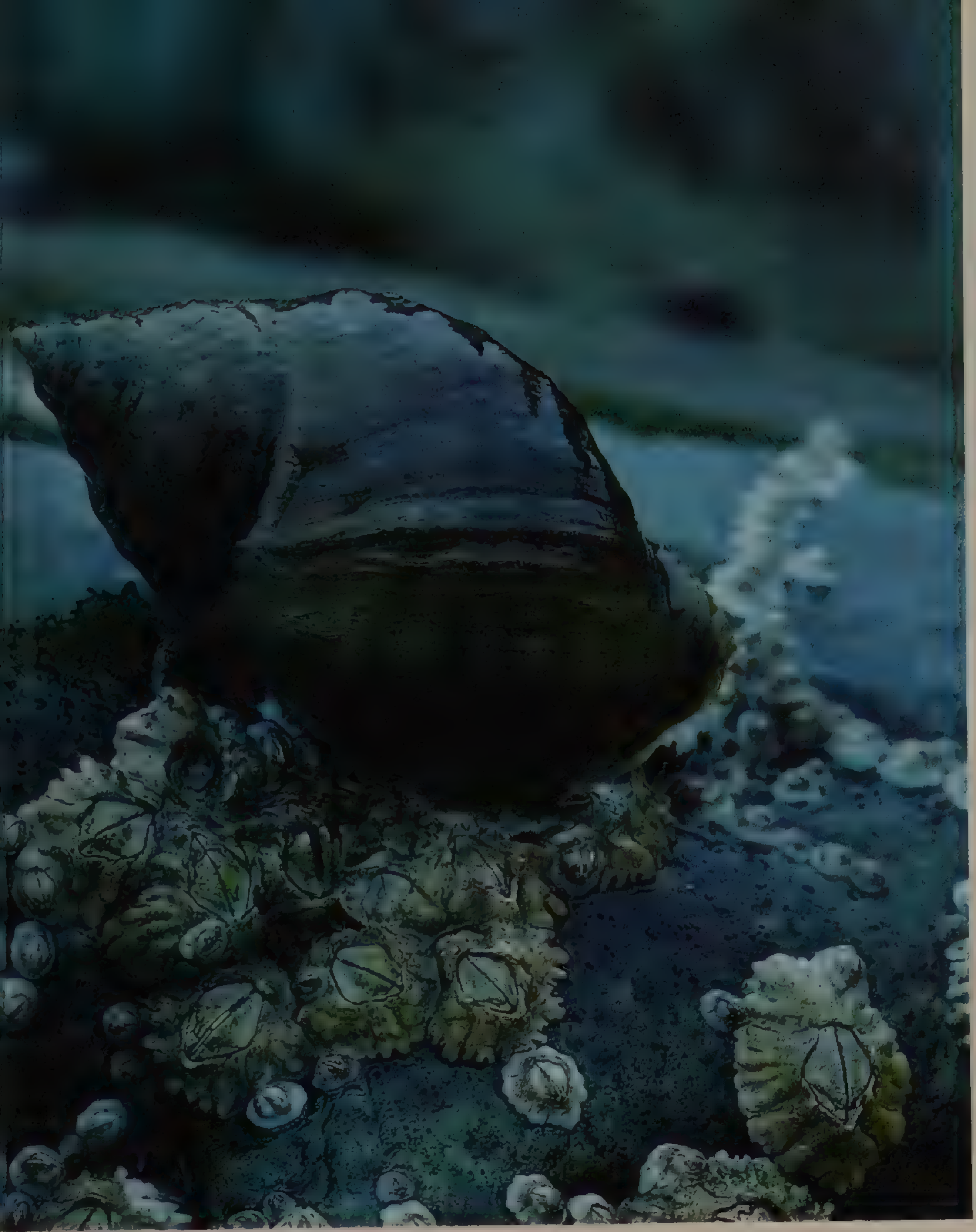
Consider the dog whelk. This snail, which preys on barnacles and mussels, abounds on rocky shores on both sides of the North Atlantic. It has no close relatives in the Atlantic, but at least seven species of dog whelk, as well as many fossil forms, are found in the North Pacific. In collaboration with Kazutaka Amano and his student Ken Narita, of Joetsu University of Education in Japan, I have shown that the earliest dog whelks lived in the waters off what is now California about twenty million years ago, during the Miocene. By the middle Miocene, several million years later, this ancestral species had spread across the Pacific to the coast of Japan.

The history remained an exclusively Pacific affair for the next twelve million years or so. The first evidence of dog whelks in the Atlantic comes from North Sea fossil deposits of late Pliocene age, about 2.4 million years old. Just when these snails reached North America is unknown, but scientists have found dog whelk fossils in Late Pleistocene deposits in Quebec, Maine, and Nova Scotia, indicating that the species has been in those waters for at least forty thousand years.

The fossil record thus implies that the Atlantic species descended from a North Pacific ancestor. But which of the many North Pacific lineages gave rise to the Atlantic dog whelk? And when and how did it migrate out of the Pacific? Timothy Collins, of the University of Michigan, began working with A. Richard Palmer, of the University of Alberta, and with me on these questions about four years ago. He and his student Ken Frazer extracted genetic material from the tissues of dog whelks that we had collected from various Pacific and Atlantic sites to determine their evolutionary history.

The Atlantic dog whelk, it turns out, is most closely related to a species whose stock can be traced back to middle Miocene time in Japan. A fossil closely resembling the Asian dog whelk is known from a beach deposit of Pliocene age near Nome, Alaska, just north of the Bering Strait. Evidently, it was able to enter the Arctic–Atlantic basin through the Bering Strait at a time when these northern waters were warmer than today. The species then spread to European shores, where the typical Atlantic dog whelk evolved.

The dog whelk is only one of hundreds of Atlantic marine species whose evolutionary origins can be traced to the North Pacific. By my most recent count, at least 274 fossil and living species of shell-bear-



Stephen P. Parker; Photo Researchers, Inc.

ing mollusks of the Arctic and North Atlantic spread from the Pacific through the Bering Strait—or are descended from those that did. Of this number, 108 are found on the American side of the Atlantic and account for about 33 percent of the 335 shell-bearing species living between southern Labrador and Cape Cod, Massachusetts. Most of them, about 80 percent, live in rocky-shore communities. Among the animals and plants of Pacific origin that have been in the North Atlantic for less than three million years are acorn barnacles, mussels, periwinkles, sea urchins, starfishes, eelgrass, and kelps. Even in sandy areas, invaders form a conspicuous part of the community of organisms, familiar examples being the soft-shelled clam and the sand dollar.

The common periwinkle represents another particularly interesting case of invasion. Today, this snail is the most abundant mollusk on rocky shores from Newfoundland to New York. It is the most important consumer of seaweeds, on which it grazes with its tonguelike radula. Like the dog whelk, the periwinkle originated in the North Pacific. After the Bering Strait opened, the Asian periwinkle—or a species very much like it—expanded its range to the Arctic Ocean and thence to Europe. Early forms of the common periwinkle—dating to about 2.4 million years ago—have been found in the North Sea region; the sculptured surface pattern of their shells is remarkably like that of the Asian species and of a closely related fossil species from California. Typical common periwinkles appeared a little later, during the early Pleistocene, about 1.6 million years ago.

Some evidence exists that this periwinkle may have grazed along the Nova Scotia shore during the last interglacial stage of the Pleistocene, about 40,000 years ago, as well as during the time of Viking occupation in Newfoundland after the year A.D. 1000. Before 1840, however, the common periwinkle was unknown to observers in Canada and the United States. After its discovery in Nova Scotia, the common periwinkle began to spread rapidly, reaching Maine by 1869 and Atlantic City, New Jersey, by 1892.

The new periwinkle must have had a drastic effect on the native animals and vegetation of the rocky shore. Before it arrived, the only other grazing snails in the area were two small, native species—both also of Pacific origin—that do not graze as intensively. By monitoring experimental plots with and without the new species, my former student Mark Bertness, now a professor at Brown University, showed that a luxuriant cover of seaweeds develops in its absence.

In historic times, European discovery of the Americas profoundly affected the animal inhabitants of shore communities. The green crab, one of the most common predators of shore snails and mussels in eastern North America, seems to have been introduced to the mid-Atlantic coast by human commerce as early as the eighteenth century; the species belongs to a lineage whose fossils are known exclusively from Europe. But it was not until the early twentieth century that the green crab began to spread north of Cape Cod. By the 1950s, it had reached its present northern and eastern limits in Nova Scotia.

In 1980, I decided to find out whether the addition of this predator to the rocky-shore community was "noticed" by potential prey. Crabs often attack by breaking the outer lip of a prey's shell. If the predator is unsuccessful, the surviving snail can repair the damage. Such repair work is recorded as a jagged scar on the shell's exterior. The northward spread of the green crab into Maine and the Maritime Provinces should, I reasoned, have coincided with a rise in the frequency of scars.

To test this idea, I needed to find collections of periwinkles and dog whelks from before as well as after the green crab's arrival. Fortunately, many museums house beautifully documented collections made from the mid-nineteenth century onward,

which have enabled us to track the responses of species to environmental changes through time. I was thus able to inspect large samples of common species from many dates and places. To my delight, a distinct rise in the frequency of shell repair was detectable in periwinkles, as well as in dog whelks.

The next question was obvious: Did the arrival of the green crab result in evolutionary changes in shell defense that would make the shell a better fortress? Did, for example, snail shells become thicker? or did the shells' openings become relatively smaller so that breaking and entering would become more difficult and time-consuming for the predator? In the case of the common periwinkle, the answer was an unequivocal no. Neither shell shape nor thickness showed any change during the last 150 years.

For the dog whelk, however, the answer was different. Shells collected after the arrival of the green crab had thicker lips than those at the same sites before green crabs appeared there. One is, of course, tempted to interpret this change in evolutionary terms: natural selection, affected by the predators, favored the survival and reproduction of individuals with thick-lipped shells.

This may not be the whole story, however. In clever experiments with the Atlantic dog whelk and with the related North Pacific dog whelk, A. Richard Palmer has shown that in the presence of crabs, individual snails develop a thickened shell lip, perhaps because they spend more time hiding and less time moving, feeding, and growing than do snails not exposed to the presence or even the scent of predatory crabs. In other words, the change in lip thickness over time may reflect individual responses rather than, or perhaps in addition to, natural selection in the dog whelk.

The flat periwinkle has also changed since the green crab came to the western Atlantic's rocky shore. Robin Hadlock's work at Yale University has shown that periwinkle shells have become higher spired and have a smaller opening since the predator's arrival, and that populations living where green crabs are absent have retained their ancestral, thin, high-spired shells. We do not know whether this change is genetic or an individual response.

These case studies make two important points. The first is that invading species can have substantial effects on native species in a recipient community. Although these effects may not always be evolutionary at first, they have the potential for becoming so over time. The second point is that such inferences of change would be impossible without museum collections of common animals. These collections are not only necessary for the proper identification of species but also for tracking recent biological history. The collections are essential as a means of documenting envi-

David Cavagnaro

Dog whelks and small barnacles, predators and prey, cluster on a rocky outcrop on Deer Island, Maine, left. A ten-rayed sea star, below, another immigrant from the Pacific, lies in a bed of mussels waiting for smaller sea stars to prey upon.

Bill Curtsinger

ronmental changes and the responses of species to them.

Some clams and snails may have extended their range from Europe to North America before human commerce brought the common periwinkle and the green crab to the New World. Still others, such as the predatory moon snail, have long histories in eastern North America. The moon snail is the most recent species in an ancient lineage traceable to the early Miocene and beyond in the great fossil deposits of the Chesapeake embayment. The quahog clam, sea scallop, bay scallop, slipper limpet, and oyster drill are other North American species that can be traced to the Miocene or earlier.

Some species belonging to native lineages have forged intimate links with immigrants. The Pacific-derived flat periwinkle, a specialized herbivore, preys on several species of bladderweeds, which likely had an Atlantic origin. None of the living North Pacific relatives of the flat periwinkle have evolved the same dietary specialization.

Why has the east coast of the United States and Canada been so kind to marine immigrants? Only about 12 percent of species in Europe's North Atlantic are of immigrant stock. In the North Pacific, the proportion is 3 percent or less, and in most tropical regions it is lower still. Perhaps currents in the northwestern Atlantic presented opportunities for species from neighboring regions to disperse here. But why—once the Bering Strait opened—did only a trickle of species from the Atlantic move into the Pacific while so many went the other way?

I think the explanation lies in the preinvasion history of the waters off eastern North America. Invading species are most likely to establish viable populations if there are few incumbents. Extinction and overexploitation of native species could therefore have provided unparalleled opportunities for the subsequent success of immigrants.

These waters witnessed an extraordinary biological impoverishment during the Pliocene, before the invasions from the North Pacific began in earnest. Stephen Stanley, of Johns Hopkins University, estimates that more than 75 percent of clam species living along the east coast of the United States during the early Pliocene became extinct before the beginning of the Pleistocene's glacial cycles. Extinction among snails may have been even more severe. Losses in other parts of the world, although still substantial, were much smaller.

Some of the void left by these extinctions was filled by immigrants from Europe and the Pacific. Surprisingly, few if any of the surviving native lineages underwent evolutionary branching to give rise to new daughter species; most simply changed or remained the same without branching. Why these survivors did not diversify is unclear. Another puzzle is why species living in the subtropical waters from the Carolinas southward did not give rise to cold-adapted offshoots along the coast from Virginia northward.

Extinctions have continued to plague species of the northwestern Atlantic even in our own day. During the last 150 years, four have become extinct: the great auk, Labrador duck, sea mink, and eelgrass limpet. Atlantic populations of the gray whale may have been exterminated as early as 1675. All these species played important ecological roles in nearshore communities. The auk appears to have been an important predator of fish, while the Labrador duck and sea mink probably preyed on marine invertebrates, including mollusks. The Pacific-derived eelgrass limpet, a small, cap-shaped snail, evidently lived and fed exclusively on the blades of eelgrass. During the early 1930s, the plant was decimated by a wasting disease that resulted in its extinction. The gray whale, which survives today in the Pacific, intensively churns the sea bottom in search of its invertebrate prey. The loss of these species in the Atlantic had potentially drastic ecological consequences for the marine communities of New England and southeastern Canada.

To make matters worse, several key players in the marine ecosystem have been very heavily exploited during the past few centuries. Visitors and settlers in the colonial period found lobsters and cod so abundant just offshore that gathering them required no special effort. Intensive cod fishing and the invention of lobster canning during the 1840s led to sharp declines in nearshore populations of these predators. Prey species, perhaps including new European immigrants, were thus released from the population control previously exercised by lobsters, cod, and the extinct predatory birds and mammals.

The history of marine life in New England and the Maritime Provinces may be unusual in that the magnitude of extinction and the proportion of immigrants were very high, but the lessons to be drawn from this history must not be ignored. Everywhere in the world, species are being driven to extinction while others continue to be harvested to population levels far below those encountered by our ancestors. More than ever before, species have been handed opportunities to found immigrant populations, with or without help from people. History tells us that extinctions and introductions bring about major changes that affect all members of the community, often in unanticipated ways. Visitors to the tide pools of Maine a century from now may well behold a scene quite different from the one we now take for granted. □

Flat periwinkles of the Atlantic coast graze on native bladderweeds, a dietary specialty their Pacific relatives never evolved.
Heather Angel

Photo/Spike Osler.

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A red fox, below, may wander within a few yards of adult brown hares about once every four nights, even when not stalking them. Experienced hares stand up, right, when they spot a fox getting too close for comfort.

Both photographs by Manfred Danegger; NHPA

No Hide, No Seek

All bets are off when the fox is having a bad hare day

by Tony Holley

Half an hour after sunset on a September evening in 1988, a brown hare crouches, grazing short grass some ten yards from the thick hedgerow of a pasture. The field is one of many at Brent Knoll on the Somerset plains, a flat expanse, crisscrossed with drainage channels, that stretches inward from the Bristol Channel coast for about fifteen miles. The failing light is just at that moment when all countryside objects switch from full color to shades of gray, black, and white. Suddenly, the hare rises and stands erect on its long back legs, its raised ears facing to the right. Watching from my attic window, 350 yards away, I swing my 20 × 80 binocular telescope to the right; at the same time I place a bet with myself. About thirty yards away and casually making its way toward the hare is a red fox. I win my bet.

As the fox approaches, the hare continues to stand, facing the danger. As I watch the hare, fanciful ideas cross my mind. Is it challenging the predator to a bout of fisticuffs or perhaps showing respect to the visitor? When the gap between them has narrowed to no more than ten yards, the hare drops and squats on its haunches. The fox stops and adopts the same posture. For nearly two minutes the animals hug the ground while looking at each other. Finally, the fox gets up and wanders past the hare into the hedgerow. The hare remains alert and, when the fox pops its head out of the hedge for another peek, again briefly rises up stiffly on its hind legs.

In the same field at sunset on a June evening in 1990, there are five hares: a doe, which is resting; three bucks, which earlier had been competing for the doe; and a six-week-old youngster, or leveret. The grass is low, having been mowed for silage only three weeks previously. Fifteen minutes after sunset a fox starts to cross the field toward the three bucks. When the fox is about forty yards off, the nearest buck stands up on two legs. The next one stands up when the fox has approached to within twenty-five yards, and the third at twenty yards. The first two hares remain in position, but the last buck moves about thirty yards away. Those farthest from the fox do not stand or show any other reaction to it.

Between 1980 and 1990 I spent more than 5,000 hours observing and recording the behavior of these animals by day, at twilight, and in the night hours. The attic of my house, which is surrounded by seventeen fields, served as a permanent blind, with windows overlooking every part of the area. I used the binocular telescope and, when a closer view was required, a modified eleven-inch astronomical telescope lens. I could determine the sex of many of the hares, and I could also identify individuals by their ears, many of which bore nicks or tears.

I kept records of all the interactions I observed between hares and foxes. If the fox was foraging, it might remain within sight of a hare for twenty minutes or more. (Such prolonged proximity was particularly common when the fox was feeding on earthworms—which in some months can provide over 60 percent of its caloric intake.) Hares generally continued feeding until the fox approached closer than about fifty yards, when the hares stood up on their hind legs, facing the fox. In a few cases, when the fox drew even closer, the hare moved away a short distance, sometimes on two legs but more often on four.

Able to attain a maximum speed of about forty-five miles per hour, a hare, below, can easily outrun a fox. Right: Unlike rabbits, brown hares have no burrows to hide in, but depend on their superb senses to warn them of danger.

Manfred Danegger

Mark Hamblin; Oxford Scientific Films

Hares can form a substantial part of a fox's diet. In one study of Hampshire foxes, hares made up 30 percent of the foxes' fare in summer and about 16 percent in winter. A high proportion of the total catch consisted of leverets. Another study, conducted in Poland, showed that foxes average six adult hares and thirty-five leverets annually. On only two occasions did I observe foxes chasing adult hares. These episodes did not last long, and the foxes were unsuccessful both times. To capture a grown hare, an animal with a maximum speed almost half again as fast as its own, the fox must depend either on stealth or ambush. Why, therefore, should a potential victim draw attention to itself by standing up when it sees a predator, seemingly inviting unnecessary risk?

Standing on the back legs is the standard response of a hare to a fox approaching it in the open, but not to a fox emerging suddenly from cover. Whenever a fox made a sudden appearance from a nearby ditch or hedge, hares either moved away or half-crouched, primed for a quick getaway. In an open field, however, a fox could not get closer than thirty yards without the hares standing up on their back legs.

Hares stood up in all heights of vegetation, from tall, flowering grasses to low-cropped sward; in darkness as well as bright daylight; when solitary as well as in groups. As the fox moved away from them, 70 percent of the hares immediately resumed the crouching posture.

When a fox approached to within thirty yards, some of the hares simply moved a short distance away. None of the hares were chased by foxes, and none left the field. When domestic dogs approached, the hares usually crouched lower and finally took flight. They never stood.

Do the hares stand in order to see the foxes better? I think not. They stand even when a fox is clearly visible from a low angle across a close-cropped pasture, and they do not stand up to observe dogs.

Is the standing hare giving an alarm signal to other hares, as some other animals are known to do? Probably not, since on 42 percent of the occasions that hares stood, they were solitary, with no others in sight. And the signal was clearly directed to the fox and never to domestic dogs.

If the standing hare is indeed signaling to the fox, what is the message? Foxes do not chase down their prey, but are likely to be ambushers and, possibly, stalkers. Dogs, on the other hand, are runners, some breeds relying on speed and others upon

stamina in the hunt. I believe that when a fox sees a hare standing up, the predator understands that it has been spotted and that a sneak attack will not be successful. A signal that the game is already over can benefit both animals, since it saves the exertion of a pointless chase. On the other hand, dogs probably do not understand this signal. A hare that stood before them would be actually inviting a chase.

Signals to predators that they have been observed—zoologists call them pursuit deterrence signals—are known from other species. Klipspringers, a kind of small African antelope, give them to black-backed jackals. Moorhens and purple gallinules similarly signal the marsh harriers that prey on them, and Thomson's gazelles signal to cheetahs (*see* "Why Do Tommies Stott?" *Natural History,* September 1988). Of related species, only the arctic hare is known to stand in the presence of its predators, such as the arctic fox, gyrfalcon, snowy owl, raven, and also, at times, humans. The function of this behavior in the arctic hare has not been investigated; but when brown hares stand up on their back legs, they are giving the fox a clear signal that cannot be mistaken for anything else. □

Its nest a simple cup in the sand, an adult least tern incubates its two eggs on Mississippi's gulf coast.
Dan Guravich

Terns on Tar Beach

As the shore becomes a dangerous place to nest, some least terns have quit the sand for another precarious site

by Jerome A. Jackson

Ooo-eee! Every time I stopped, I stuck for a second and then took a bit of bubbling black tar with me as I moved on. The glare from the noonday sun made me squint. The heat was unbearable—and the cause of the sticky tar and thick tar fumes. A little glimpse of hell? No, it was simply the roof of the Singing River Mall in Gautier (pronounced "Go-shay"), Mississippi, on a July day in 1981. I had stopped at the mall for lunch and noticed least terns flying to and from the roof. Could they be nesting there? The mall manager assured me they were and invited me to take a look, but admonished me not to stay too long or disturb the birds. I knew better than to do that, and I couldn't have withstood the heat if I'd wanted to stay. Yet about 200 pairs of least terns were nesting on the roof, their simple nest scrapes scattered across the veneer of pea-sized gravel atop the hot, viscous tar. Dozens of chicks crowded together in the shade along the walls at the roof's edge. Why were they here? Could they possibly survive?

Least terns, which winter in the West Indies and nest on coastal beaches and river sandbars in North America, have had troubled times since the late 1800s, when they were considered just the right size to adorn ladies' hats. The birds were taken by the thousands, particularly from the Atlantic and Florida coasts. Throughout most of the twentieth century, California and Atlantic coast populations also declined as prime beach property was invaded by growing human populations. In the interior, least terns that nest along major rivers also suffered losses as their sandbar nesting areas were eliminated by channel dredging, damming and flooding, and runoff of pollutants.

On the northern gulf coast, however, the lot of least terns improved when plume hunting ended. Because the mainland coast lacked extensive beaches, these birds nested primarily on barrier islands, which had the advantage of being too far offshore to attract many beachgoers and too vulnerable to tropical storms to allow human settlement.

When mainland colonies of least terns were discovered in coastal Mississippi in 1936, they were invariably in habitats created by humans: bare areas next to bridges and construction sites, dredge spoil dumped in marshes, and man-made beaches. The longest such beach in the world is a twenty-six-mile-long, hundred-yard-wide strip created in 1952 along the Mississippi Sound in Harrison County, Mississippi. The sound's sheltered waters provide good fishing, and busy U. S. 90, which runs along the entire length of the beach, selects heavily against dogs and cats that might otherwise find an easy lunch. This would have been a paradise for nesting terns were it not for the throngs of beachgoers and the regular beach maintenance by tractors that raked the sand at about two-week intervals.

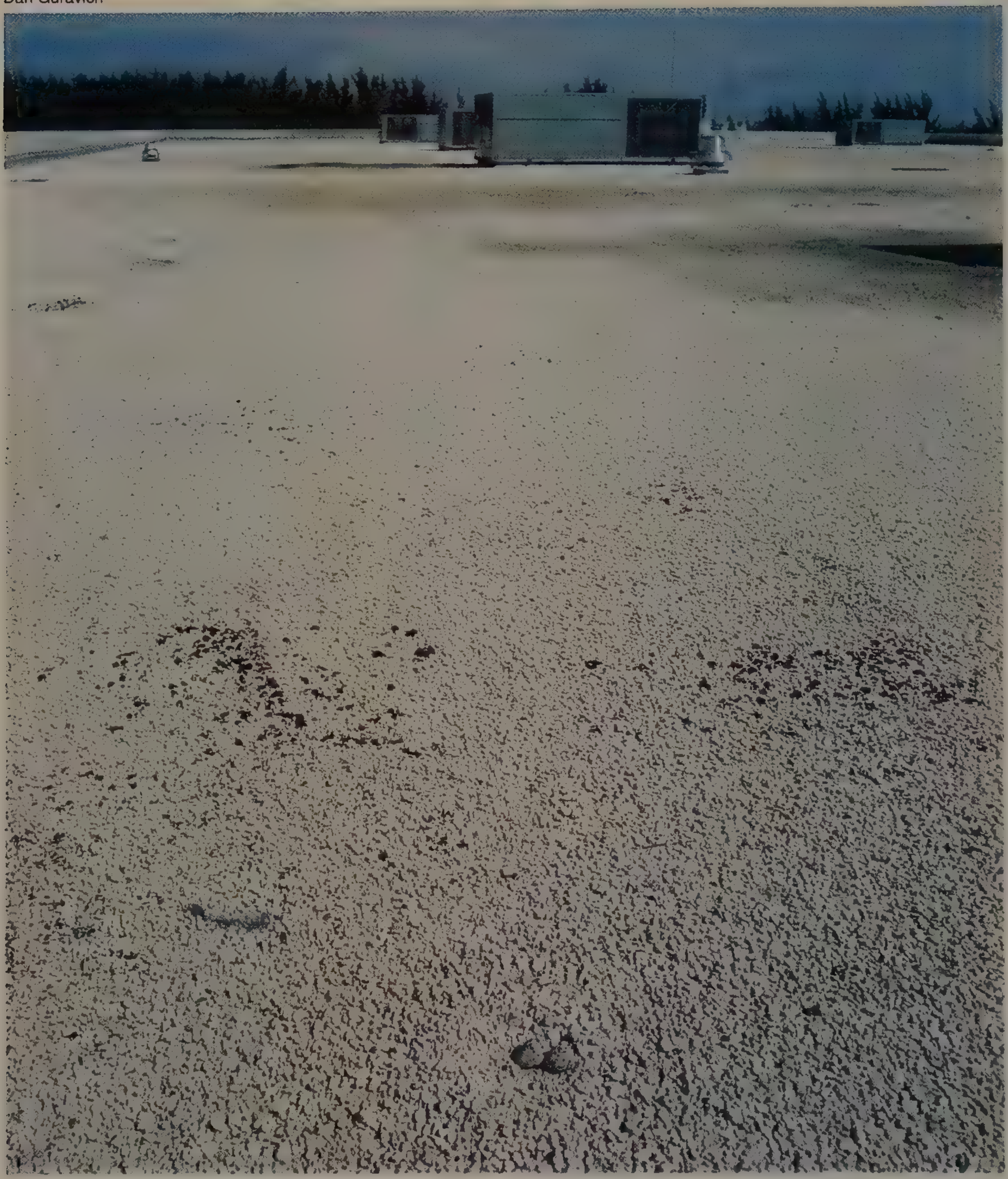
Least terns tried nesting on the new beach anyway. Time after time, eggs would be laid, only to be raked away before they could hatch. The beach had become what is known today as an ecological sink—a place attractive to wildlife, but one in which little, if any, successful reproduction can occur.

In 1974, concerned citizens began marking least tern nests and urging their protection, and their efforts paid off. In 1975, more than 1,000 pairs nested on the

SINGING RIVER MALL
SEARS

The roof of the Singing River Mall in Gautier, Mississippi, nearly three miles from the coast, was first adopted as a nesting site by least terns in 1981.
Stephen Kirkpatrick

Speckled tern eggs (foreground) are camouflaged against the superficially beachlike surface of a mall roof, below. Shade and water condensation afforded by air-conditioning units substitute for the readily available water and ocean breezes of the birds' natural nest sites.
Dan Guravich



mainland (non-barrier-island) beaches; in 1983, more than 6,000 pairs. Since then, the main nesting colony in Gulfport has annually supported from 2,000 to more than 3,000 pairs, making it the largest least tern colony in the world.

As tern populations have grown, so have the sheer numbers of beachgoers and consequent disturbance of mainland colonies. Despite efforts to protect nesting areas, the Fourth of July has always meant trouble for the terns. Fireworks turn beach colonies into war zones with casualties all too obvious on the morning of the fifth. Notwithstanding the setbacks, however, the terns have adapted and resisted. Terns nesting on the mainland beaches, for instance, are much more aggressive in defending their colonies than are barrier island nesters. A human straying into a mainland colony can expect to be defecated on or even hit by the bill of a diving kamikaze tern. Small groups of least terns have nested with some success on areas of the mainland beach outside of the main protected sites, but numbers of these splinter colonies have steadily declined. Not one was found in 1992, when human use of the beaches seemed at an all-time high. Newly established jet ski rental businesses now attract more people to the beach. Jet skis also create constant ripples and waves on the usually placid waters near the colony that the terns use for feeding. This means that the tiny fishes the terns feed on are harder for them to see, and the birds must go farther to find food for their young.

Least terns are relatively long-lived birds; some survive twenty years or more. After the tern population explosion of the 1970s, the numbers of Gulf Coast terns may have reached a plateau, once again limited by availability of nesting habitat. With their numbers all built up and no place to nest, breeding terns have pioneered some nontraditional nesting sites, including the graveled rooftop of the Singing River Mall.

Rooftop-nesting least terns were first discovered in Mississippi at the Navy

Dan Guravich

Least tern chicks, hatched on a rooftop, huddle in a shaded corner for relief from unrelenting heat, left. Such chicks often suffer burned feet from sticky tar. When gathered in such congregations, they are easy pickings for predatory crows. Young siblings, above, reveal the color variation in the down of tern chicks: one is the color of dry sand; the other, of wet sand.

Jerome Jackson

Seabee base in Gulfport in 1977. They have also nested on rooftops in Florida and other coastal states. Are these terns on the leading edge of adaptation to the modern world? Perhaps. They certainly illustrate an important level of flexibility in their choice of nest sites. Graveled rooftops do have some characteristics in common with the bare beaches the terns have always used: they are large, flat, open areas with no vegetation. Natural colony sites often have bits of shell and other materials that give a varied color and texture to the nesting area, helping the mottled eggs to blend in, and the multicolored pea-sized gravel atop the Singing River Mall might serve a similar function. But a roof is not a beach, the most obvious differences being that roofs are not next to bodies of water, are well above ground level, are devoid of sand, and are often sites of air-conditioning units, vents, and other unnatural structures. Twentieth-century terns have learned to accept the accouterments of the human world as part of their own. The advantages are freedom from human disturbance and protection from dogs and cats. Roofs are unaffected by storm tides and not subject to the natural succession of plant growth that limits the years of usefulness of natural sites. But other problems can be so severe that rooftops may be another example of an ecological sink.

When I first began studying the least terns at the Singing River Mall, I was amazed at the difficulties the birds faced. The pea-sized gravel was so sparse that most pebbles were stuck in the asphalt base, leaving the birds little loose gravel into which they could hollow their cuplike nests. Much more than on a beach, tern eggs were simply laid on the bare surface. One section of the mall roof had a slight slope to it, and terns nesting there lost their eggs if they left them unattended for mere

Jerome Jackson

A discarded paper cup, left, evidence of burgeoning numbers of beachgoers, below, offers a week-old chick temporary protection from the sun and from predators.

Dan Guravich

seconds during high wind or rain—the eggs simply rolled downhill. Another obstacle to success was the distance the terns had to travel for food. Mississippi Sound is nearly three miles to the south and, to the north, the Intra-coastal Waterway is not much closer. Birds went in both directions for food, mostly to and from the south, in a steady flow over mall parking lots, a K-Mart, two highways, a pine forest, and an urban residential area.

Another hazard the terns faced was the fish crows that found eggs and chicks were easy meals. Eggs were conspicuous against the fine gravel, and chicks had no clumps of vegetation in which to hide. Instead, they congregated in the shadow of the three-foot-high wall surrounding the roof's edge. Marauding crows could herd them into corners, where there was no escape. The only defense was the continual mobbing of crows by adult terns, but often while one crow was being mobbed, another would slip through tern defenses to snatch a chick.

By far the greatest threat to the terns, however, was heat. Black asphalt showing through the veil of pebbles heated quickly, becoming so soft at midday that unattended eggs would sometimes stick to the roof like Br'er Rabbit to the fabled tar baby. My students and I monitor the colony each year, but we work at nests and band chicks only in early morning and late afternoon to minimize stress to the birds. What we found when we started banding chicks was appalling. Nearly every chick had burned and blistered feet. Often the webbing between chick toes was missing or perforated as a result of the sores.

Least terns are birds of the open beach and hot environments, but in a natural setting, sea breezes provide some relief. On the Singing River Mall roof, the three-foot-high parapet may keep the chicks from plunging to the parking lot below, but on most days it also blocks even a whisper of wind from cooling the roof surface, which at times exceeds 114° F.

Each year I have studied them, some chicks have fledged, and the next year the birds have returned to nest. Salvation from the heat came from several quarters. The parapet surrounding the mall roof, though blocking air flow, cast a shadow on one side or another at most times of the day, and chicks followed the shadow as it moved. In good years, a shaded corner might host a crèche of thirty downy chicks. A second fortuitous feature of the rooftop is the set of widely dispersed air-conditioning units. On the hottest days these run constantly, wringing moisture from the mall air and depositing the condensation in shallow puddles adjacent to the units. Both chicks and adults use this water for bathing and drinking.

The third defense against the heat is something that was first described along the Mississippi River in 1896 by one Guideon Mabbett, who noticed that eggs often had tiny, mysterious droplets of water left on them. The purpose of the droplets is now known. In a behavior known today as "belly-soaking," an adult

Dan Guravich

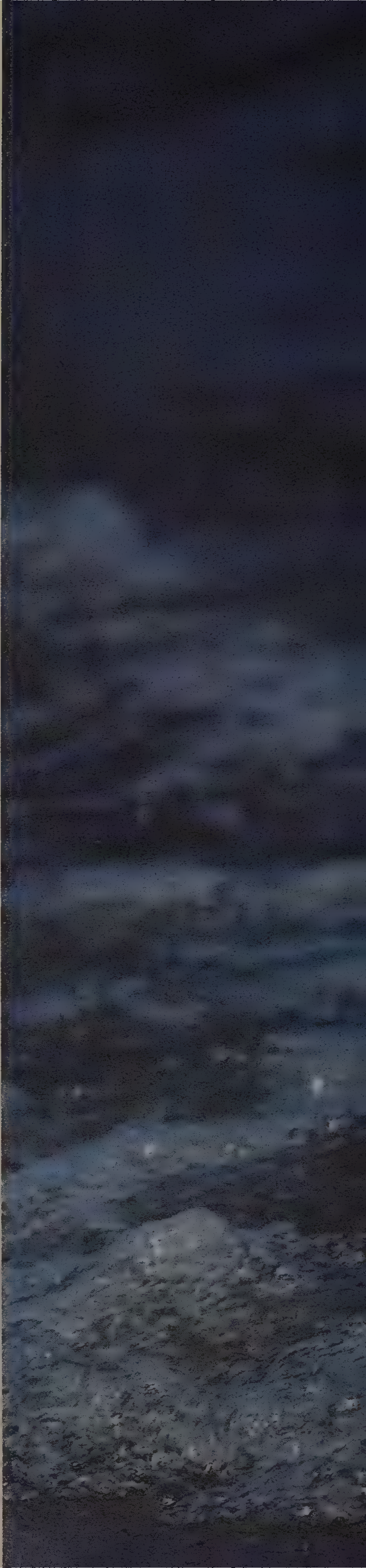
Chicks that stray from patrolled and protected nesting areas often die beneath the wheels of beach maintenance vehicles, below, or the feet of beachgoing humans. To feed itself and its young, an adult least tern, right, must find calm, unrippled waters in which it can spot tiny fish.

Jerome Jackson

bird wets its belly feathers and then drips water from its breast onto eggs or chicks to keep them cool in unusually hot environments. On the Singing River Mall, belly-soaking is often an everyday necessity. By midmorning, the terns no longer need to sit on eggs to keep them at a warm enough temperature for the embryos to develop. Instead, they have to stand over the eggs to shade them. As temperatures continue to rise, each adult dips into nearby water—often the air-conditioning condensate—returns to the nest, and drips water onto the eggs or chicks. A chick may even reach up and swallow droplets, looking like a suckling mammal. As belly feathers dry out, the attendant parent becomes fidgety as it waits for its returning mate and may risk leaving its nest in the open sun for a few seconds to quickly dip in nearby water, for only that can cool its eggs or chicks. On the hottest afternoons, exchanges at the nest become increasingly frequent as adults are stressed by the heat and belly feathers dry out more rapidly.

By the mid-1980s, the Singing River Mall colony was dwindling. Fewer chicks fledged. Fish crows had honed their chick-capture strategies and were eating themselves out of a food supply. The chicks and eggs were too conspicuous against the pea gravel. But then along came Sears.

When a Sears Roebuck store was added to the mall, a different type of gravel roof was used. Instead of small pebbles on tar, one- to two-inch white and tan rocks covered a plastic mat. Although the rocks were not embedded in the mat, they were simply too large for the terns to move. Nonetheless, the Sears roof was adopted immediately. The light-colored rocks reflected more of the heat. They were also mottled in much the same manner as eggs and chicks, allowing them to blend in extremely well. In 1992, a few terns attempted to nest on the old roof, but all nests were lost. The main colony was on the Sears roof and, although fish crows still took a toll as chicks congregated in the shade of the parapets, many young fledged. This summer, we plan to scatter small, wooden-slatted teepees about the roof as chick shelters, We hope their design, which provides room for chicks to hide out of reach of crows, will lessen losses to these predators. With their determination and adaptability and a bit of help from us, least terns are hanging on—some say thriving—in this bit of the human world. ☐



At the end of a summer New Year festival in the Yunnan village of Puge, celebrants troop away from the festival grounds and return to their fields.
Nevada Wier

When the New Year Comes Twice

In southwest China, the Yi people greet the New Year in winter—and again in summer

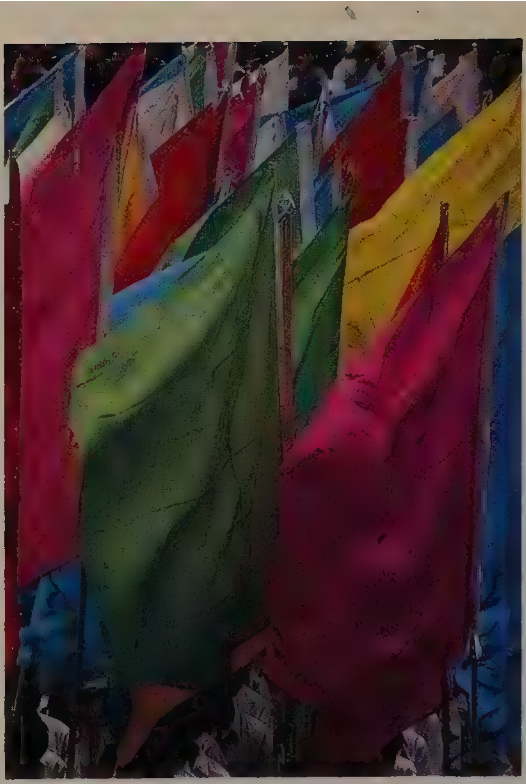
by Li Weibao

In the provinces of the Chinese southwest—Yunnan, Guizhou, and Sichuan—live some six million Yi people, one of China's fifty-five minority groups. Although the Han people make up the vast bulk (92 percent) of China's population, the Yi have maintained their distinct traditions, language, and culture, mainly because of their relative geographical isolation. One of the most interesting survivals is the Yi custom of two separate New Year celebrations, one in winter and one in summer. These festivals are perhaps the last vestiges of a ten-month calendar that was once widespread in southern China and that had been in operation for several thousand years—possibly longer than any other in world history—and was still used in some remote Yi villages as recently as forty years ago.

Until early in the present century, the standard Chinese calendar was luni-solar. The year consisted of twelve lunar months of 29 or 30 days (between new moons), making some 354 days in all. To keep the year in step with the solar year (365¼ days) and the seasons, a thirteenth month was inserted every three years or so, according to carefully prescribed rules. Although this calendar was replaced for official purposes by the Gregorian calendar in 1912, it is still used in the countryside, as well as in Hong Kong and Taiwan. Chinese communities throughout the world continue to celebrate the lunar New Year at the second new moon after the beginning of winter, no earlier than January 20 or later than February 20.

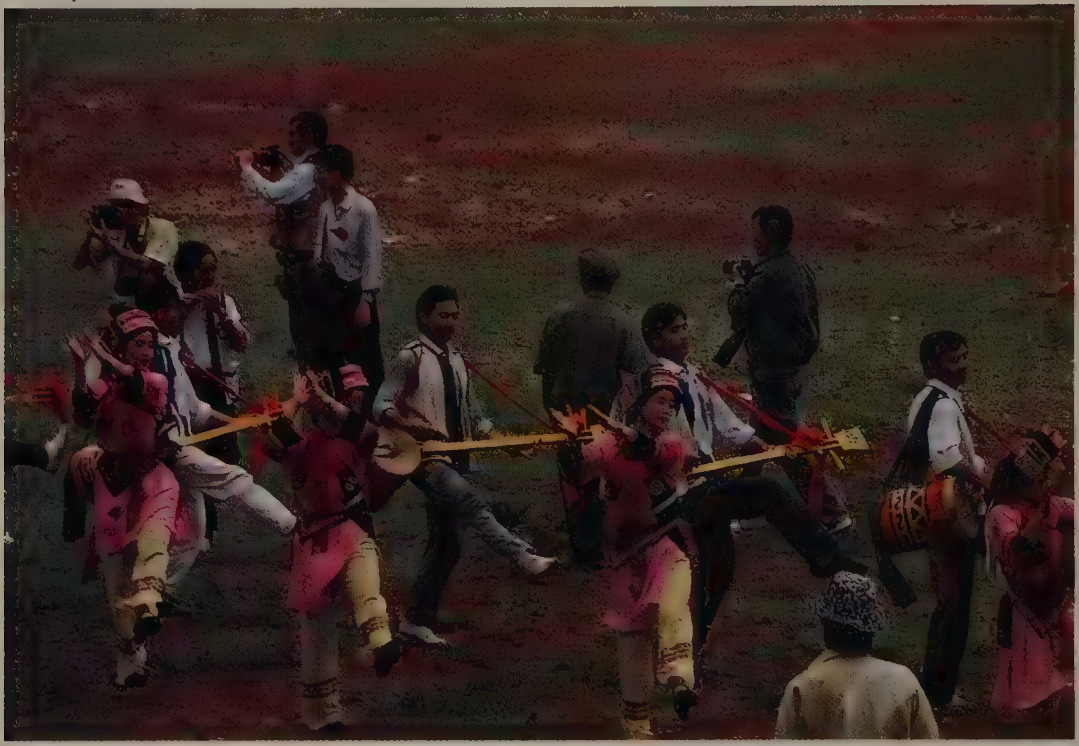
The ten-month calendar of the Yi people was devised in ancient times by an astronomer named Shidi Tianzi, whose calculations accorded with solar observations. With the help of four assistants, Shidi used a vertical pole as a gnomon, or sundial, to mark the positions of sunrise and sunset during the year. He also noted the seasonal changes in the length of the noon shadow of the gnomon. After protracted observations, he was able to accurately fix the dates of the winter and summer solstices and to make a precise determination of a year's length.

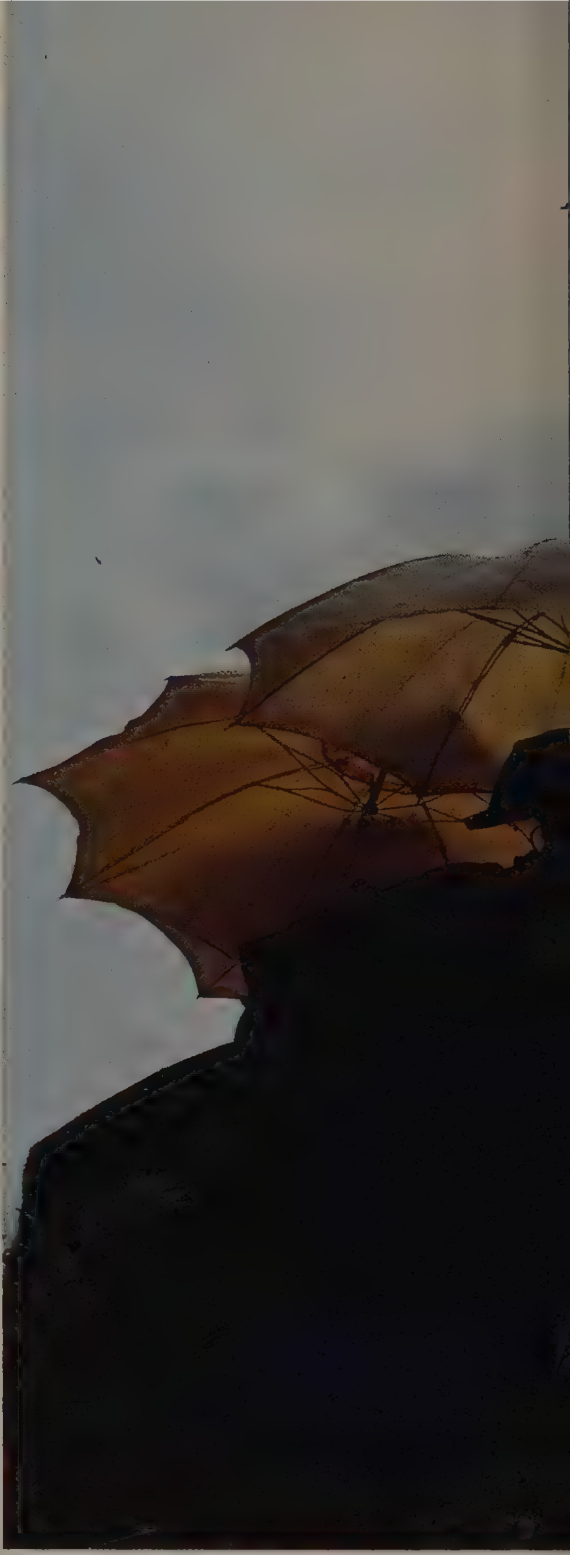
Lois Riley Wheeler



In some Yi villages, New Year festivals open with a parade of colorful flags, right. Far right: Women perform a circle dance under yellow parasols. Below: Musicians play stringed instruments while dancers keep step with the melody; below right, they promenade onto the ceremonial grounds.

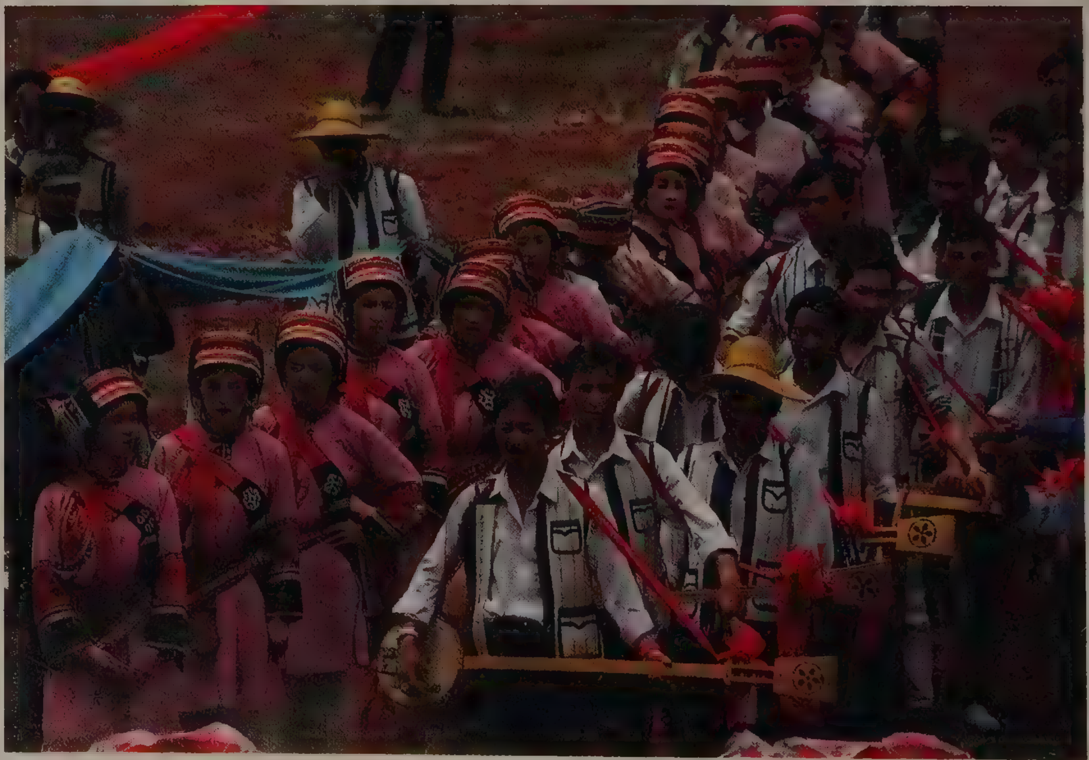
Lois Riley Wheeler





Just when Shidi lived is not known with any certainty; however, legend has it that his descendants are in the 248th generation. Allowing an average of twenty-five years from one generation to the next would mean that the ten-month calendar could have originated as long ago as 4000 B.C. According to astronomical records, however, it probably developed about 1500 B.C. during the Xia dynasty. By the first century A.D., the calendar was used throughout southern China and as far north as the central plains.

Shidi's ten months were simply artificial divisions of the solar year, not unlike the twelve months of the Gregorian calendar worked out in 1582 by Pope Gregory XIII. The year began about the time of the winter solstice, and each of the ten months contained thirty-six days; the remaining



Lois Riley Wheeler

Nevada Wier

five or six days were set aside for festivities. Here we have an interesting parallel with the predominantly solar calendars of ancient Egypt and pre-Columbian America, in which a year consisted of twelve months of thirty days, followed by five or six additional days.

The New Year in the ten-month calendar was called by a variety of names meaning "the days when a new year replaces the old one and sacrifices should be offered to the deities of ancestors." Originally, individual months were named after wild animals: the tiger, otter, crocodile, boa, pangolin (scaly anteater), muntjac (barking deer), blue sheep, ape, leopard, and lizard. Days were also named after these same animals, and during the course of a year, each was used in rotation thirty-six times.

The five or six extra days at the beginning of a year were numbered rather than named, a practice dating from about 1000 B.C. that became so widespread for a time that it left its mark on ancient Chinese folksongs of the *Shijing* (*Book of Songs*). The ten mystical numbers of Heaven found in the Chinese *Book of Changes*—known to us as the *I Ching*—are also thought to be derived from the ten months of the Yi year.

With the Tang dynasty and the influence of Han culture, animal names for the months were replaced by the five elements of Chinese philosophy: *tu* (earth), *jin* (metal), *shui* (water), *mu* (wood), and *huo* (fire). The first five months formed the yang year, and the next five months made up the yin year. Each season consisted of two months (or seventy-two days), containing a yang and a yin month for the same element. These archaic month names still remain fresh in the memory of some elderly Yi people who live in the villages of northwest Yunnan.

The ten-month year was divided into two halves, each ending at one of the solstices. The yang year was the period of plant growth, while the yin year was the period of plant maturation. Festivities marked the end of each short year. Although the ten-month calendar now belongs to history, these two New Year celebrations are still an important part of Yi life in parts of Yunnan.

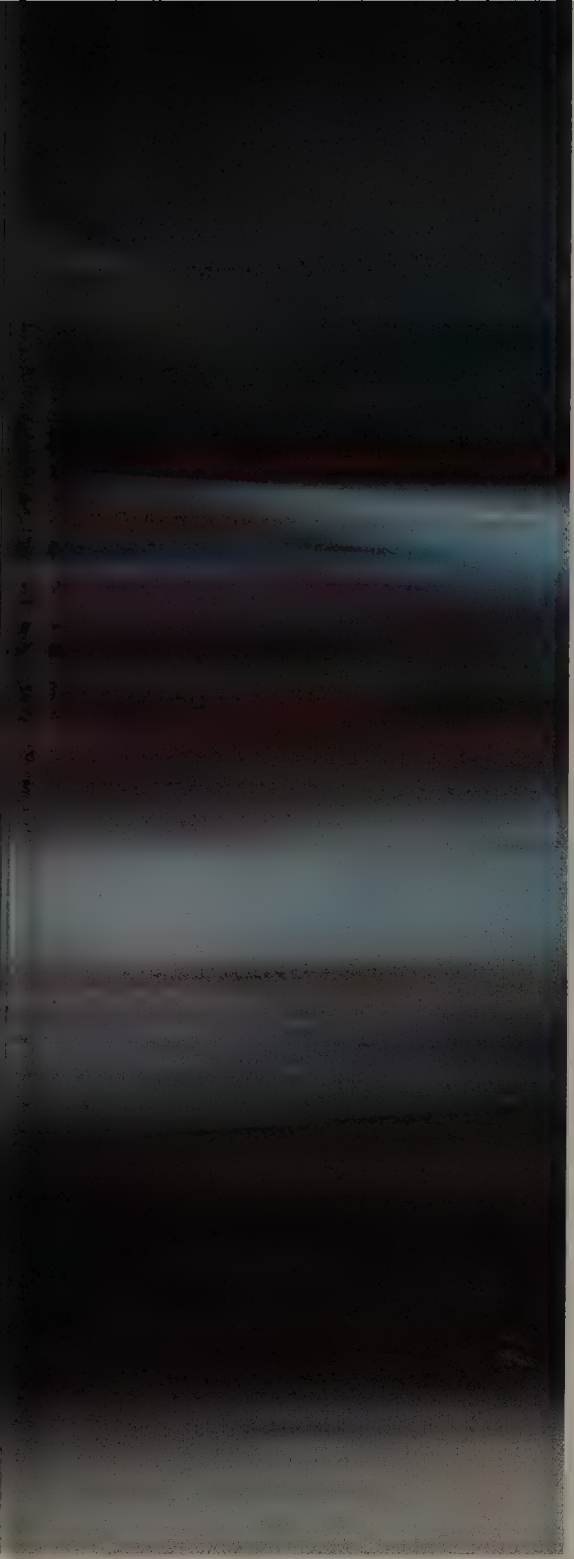
Traditionally, the *Kushi* festival was celebrated at the winter solstice and the *Zhai* festival 180 days later at the summer solstice; today, however, there are marked local variations in the dates of these events

because of the development of divergent customs in the various provinces where the Yi live. By 1800 B.C. in certain regions, observations of the Big Dipper determined when the year began. Since the length of a sidereal year is slightly longer than that of a solar year, the people who followed this practice gradually celebrated the two New Year's days later and later in the year. The difference amounted to nearly one and a half days per century. Also, after about A.D.700, the lunar calendar, which had already been adopted throughout much of northern China, became even more widespread. Gradually, the two New Year festivals became linked to the lunar calendar and thus not closely tied to the seasons.

Nowadays, the *Zhai* festival in Yunnan is celebrated on the twenty-fourth day of the sixth lunar month, which usually falls any time from mid-July to late August in the Gregorian calendar. In some villages, the festival lasts for three days and is called the Great New Year. The *Kushi* festival, on the other hand, is celebrated in eastern Yunnan from December 25 to 29 (or 30) and in western Yunnan a month earlier. Certain villages even hold the event for five days in mid-October. In parts of Sichuan Province, the festival has no fixed dates but is held some time in November or December on auspicious dates selected by a shaman.

Regardless of when they fall in the year, the festivals are enthusiastically celebrated by the Yi. Originally the *Zhai* festival was a time when sacrifices were offered to the ancestors. This gradually evolved into a lively ceremony in which prayers, songs, dances, and torch displays

Lois Riley Wheeler



Nevada Wier

Horse racing, left, has become an important event in recent New Year celebrations. Bottom left: In another type of competition, bulls meet head on in the arena as their handlers look on. Below: Long ago, the summer New Year celebration culminated in a parade of men carrying burning tree trunks, but because timber is scarce today, branches and grasses are used for torches.

Nevada Wier

were offered to the deities and ancestors to ask for a bumper harvest of cereal crops.

In Mile County, in the central part of Yunnan Province, the summer *Zhai* festival is fairly typical in that on the morning of the first day, the farmers of one or more villages assemble on a fixed open ground (in large villages, a center marker is erected). People who are talented in singing, dancing, and playing of musical instruments take the lead in going to the center ground to perform the traditional rites for a good harvest. As the gaiety increases, the festival loses some of its formality. Spectators often give impromptu performances, and children form their own recreational circle. Festivities do not end until sunset.

On the second day, those elderly people who are held in high esteem take charge of sporting activities. Archery contests have been replaced by wrestling contests, probably because of the limited space of the competition area, which is located inside the village or on open ground nearby. In bygone days, wrestlers could take up a challenge on the spot, but today, rules are more formalized, and competitors are organized into groups and must enter their names in advance. The contest opens with an entrance ceremony, after which the individual bouts commence. Women's wrestling has gained in popularity in recent years, and in some villages ox-fighting is also practiced. Winners of the various events may be given prizes or cash awards; however, this is by no means the rule, as the main purpose of the sports is entertainment.

After dark on the evening of the third day of celebrations, torches are lit. In the past, every family prepared a pine trunk at least six and a half feet in length, which was processed in advance so it would burn more easily. The entire village was involved in making a huge torch and placing it in the village center. With nightfall, the torches were lit simultaneously and carried through the village and out into the fields. The procession of torchbearers resembled a long snake glittering under the night sky and was accompanied by a display of fireworks that, according to the elders, drove away insect pests. Today, owing to the shortage of trees—and the need to conserve those that remain—this magnificent spectacle is seldom witnessed.

The winter's *Kushi* festival is highly colorful because the women make new clothes to be worn for the event, and all the villagers, especially the children, dress up.

All Yi women dress up elaborately for both winter and summer New Year festivals, but these embroidered jackets are traditionally worn by women of a particular group, the Nisu.
Nevada Wier

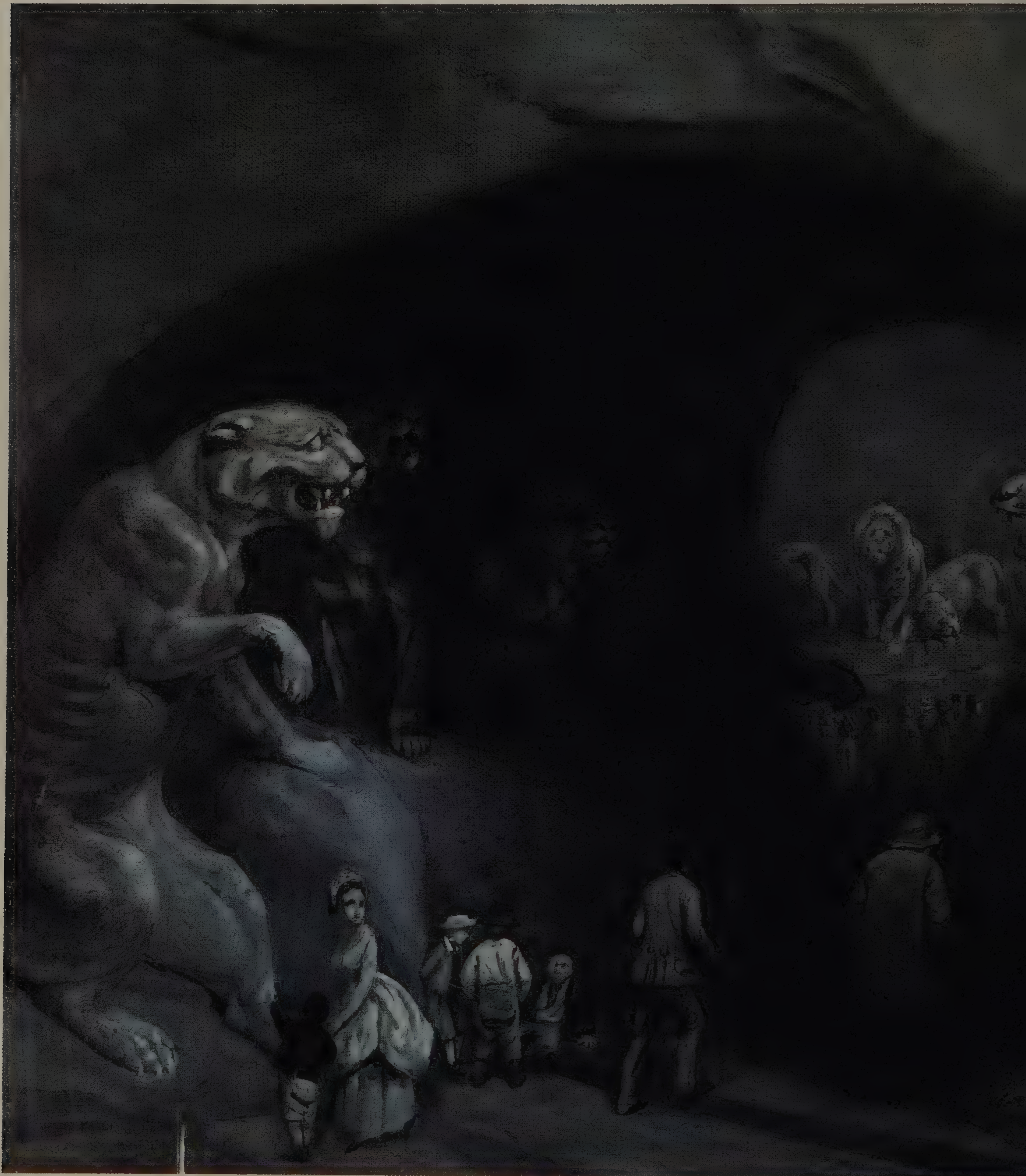
Pork, vegetables, and wine—purchased by the men, often from faraway markets, and prepared by the women—are served. The ceremonies in Honghe and Shiping counties are typical of *Kushi* festivals throughout Yunnan.

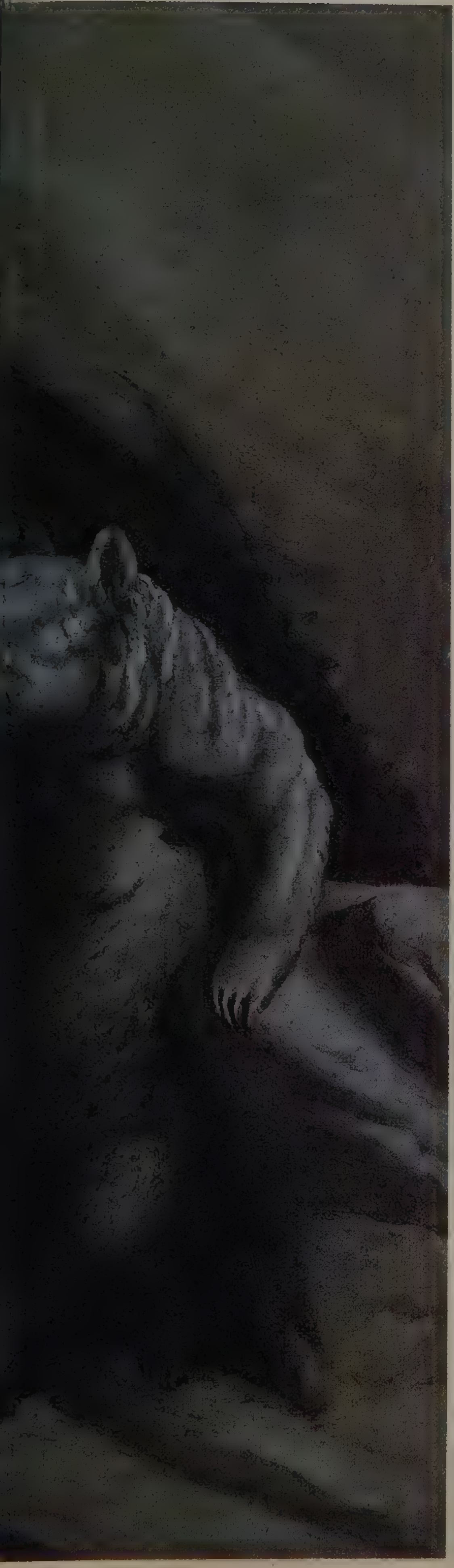
What started as a sacrificial rite has become a great thanksgiving to the deities and ancestors for the crops that have been harvested. Today much of the religious significance of the festival has been lost, although sacrifices are offered twice daily while the event continues. Every day before breakfast and again before supper, an elderly man from each family takes a serving tray bearing four bowls of rice (each containing some pork), four pairs of chopsticks, and four cups of wine to the family altar. Bending down before the altar, he raises the tray above his head for a moment; then piously invites the ancestors and the various deities to enjoy their meal. Before the whole family sits down to enjoy the sumptuous feast, the children also pay homage to the deities and ancestors (although this has become little more than a perfunctory gesture).

In ancient times, hunting of wild animals was a feature of the first day of the *Kushi* festival, and those who caught ferocious animals were feted as heroes, and the animal skins were used to make clothes for them. In more recent days, however, as wild animals have become more and more scarce, this aspect of the festival has gradually died out.

Before 481 B.C., the *Kushi* festival was a time of great revelry, when people disguised themselves with masks. Today, young men and women still meet and court on the outskirts of the village, where they entertain one another with specially composed songs and dances. Often this occasion is where future marriages are arranged, and the ceremonies take place the following autumn before the next *Kushi* festival. After dark, the young men and women sing and dance both indoors and outdoors to the delight of the elderly onlookers. In Yunnan Province, the boisterous revelry of ancient times persists today in the bold and unrestrained ceremonies of a bygone age. □

The American Museum of Natural History celebrates its 125th anniversary this year. If New York City politics had gone differently in the 1860s, another kind of institution might now be standing on the Museum's present site next to Central Park.





Grotesque figures would have lined William Holbrook Beard's proposed subterranean entrance from Central Park to a museum in Manhattan Square.
Private collection

The Museum That Never Was

by Robert McCracken Peck

When President Ulysses S. Grant laid the cornerstone of the American Museum of Natural History on June 2, 1874, he ended the debate about how to utilize a nineteen-acre site administered since 1864 as part of New York's Central Park. This "rugged and unimproved ground," known as Manhattan Square, extended from Eighth Avenue (Central Park West) to Ninth Avenue (Columbus Avenue) and from Eight-first to Seventy-seventh Streets.

After the speechmaking, the Museum's first superintendent, Albert S. Bickmore, placed a collection of souvenirs—a dozen daily newspapers, a dollar bill, some coins, and some official documents—into a small copper box in the cornerstone, and the ceremony drew to a close. For Bickmore, the occasion was a particularly exciting one, for he had been planning a natural history museum for New York City ever since his graduate studies with the Swiss-born naturalist Louis Agassiz, founder of Harvard University's Museum of Comparative Zoology. So intent was he on the idea that before embarking on an overseas research expedition in 1865, he had gone so far as to commission plans for the museum he hoped one day to build.

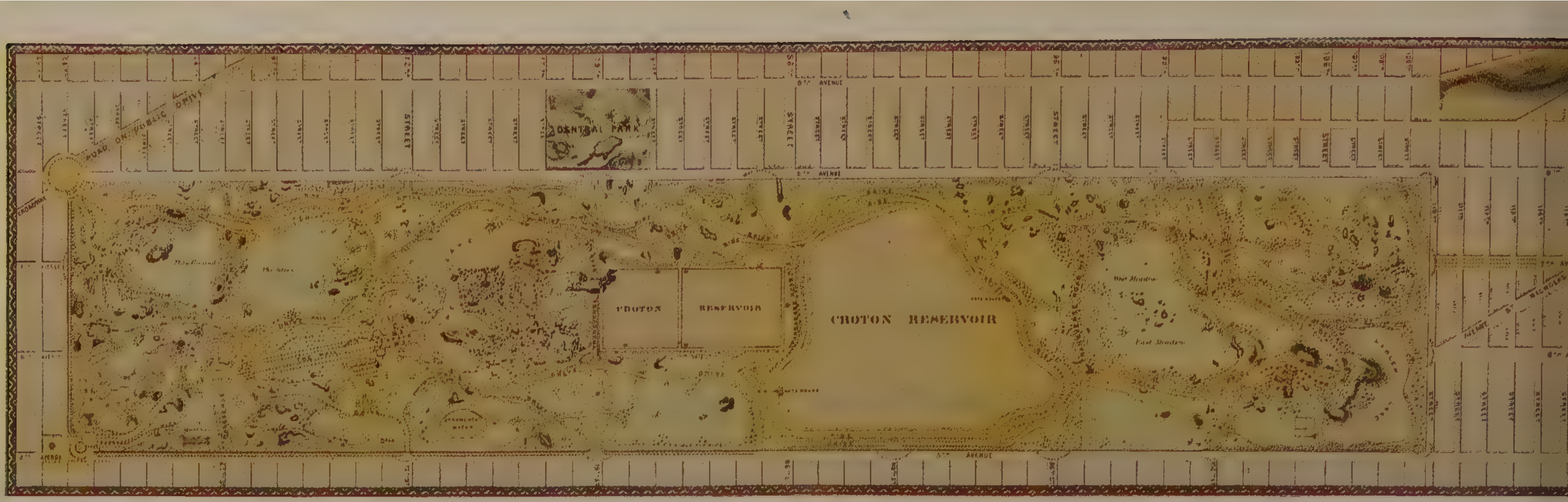
When Bickmore settled permanently in New York in 1867, the city had a population of almost a million. It surpassed Boston, Philadelphia, and Baltimore in size and wealth, yet could boast no museums of distinction. Among New Yorkers eager to prove themselves cultured citizens, Bickmore found backers for his scheme. He also discovered that his was not the only museum plan afoot. Of the various competing proposals under consideration, two others also focused on Manhattan Square.

The first of these came in 1866 from Frederick Law Olmsted and Calvert Vaux, who had designed New York's 840-acre Central Park less than a decade before. To augment their original scheme for the park, they now suggested creating a zoological garden and natural history museum and placing both in Manhattan Square. The two men wrote a letter to the Central Park commissioners, in which they outlined their ideas.

> It seems eminently proper that the Park should contain within its limits, a collection representative of the animal kingdom so liberally arranged, that it will afford ample gratification and entertainment to the public generally and at the same time be especially valuable, as an adjunct to the Common School System of education.

The designers planned an arched tunnel entrance from the park, entering the square just south of Seventy-ninth Street. The project received enough support to find its way into the commissioner's 1866 annual report and the map that accompanied it.

Not long after Olmsted and Vaux's proposal reached the Central Park commissioners, artist William Holbrook Beard came up with an even more ambitious plan for Manhattan Square: a National Academy for the Advancement of Art. Al-



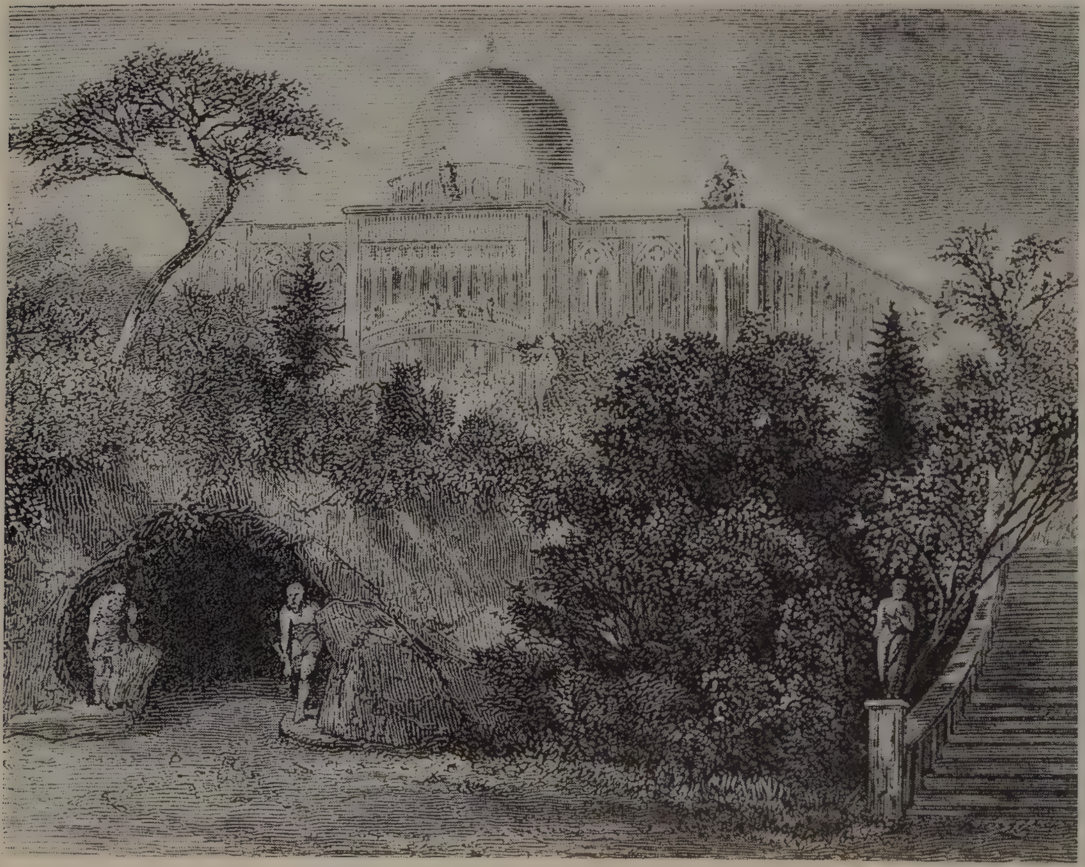
though he had no previous experience as an architect, Beard was well known as an artist. He was especially admired for his ability to paint animals—both as themselves and as caricatures through which he lampooned Victorian society. Beard traveled in influential circles in the art world, sharing studio space in New York with Albert Bierstadt, Frederic Church, John LaFarge, and later, Winslow Homer—artists of immense popularity whose paintings captivated audiences with their strong visions of America. Both Bierstadt and Church contributed to the planning of the Metropolitan Museum of Art in the late 1860s, and Church, in 1872, became a member of the powerful Central Park Commission. Beard's museum design was backed by many of his artist friends and by Henry Keep, a wealthy businessman who was, to use a contemporary phrase, "an architect of his own fortune." While not a member of the highest level of New York society, Keep was eager to join its ranks. With little more than a high-school education, he had worked his way from a poorhouse orphan and teamster on the Erie Canal to a position of great wealth and power. Keep's competitive spirit may have prompted his pledge of $1.5 million of his own money in support of Beard's museum—an astounding sum for its day.

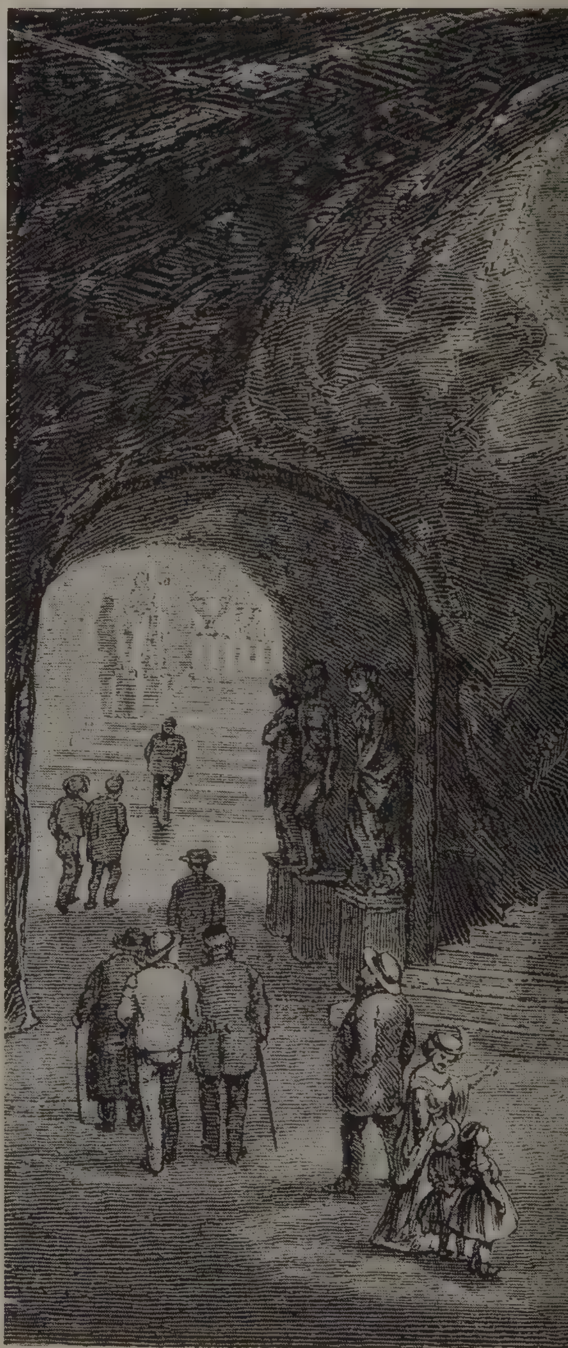
With Keep's encouragement, Beard began planning his museum sometime in the late 1860s. Although Beard himself never wrote about the project, his ideas were summarized and his designs reproduced in *Scribner's Monthly,* an influential and popular magazine of the period with a national circulation.

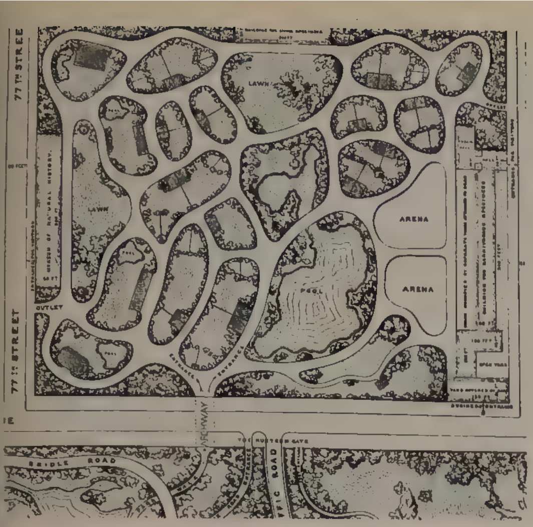
According to *Scribner's,* Beard's Manhattan Square museum was to have been housed in an immense, domed building of a hybrid architectural style. His main focus, however, was on the museum's two entrances which, like Olmsted and Vaux's

Beard planned to have stone figures representing Ignorance and Superstition at the main museum entrance, below. In his depiction of the antechamber, right, a colossal, seated figure guarded the museum's portals.

Both photographs by Peter Goldberg





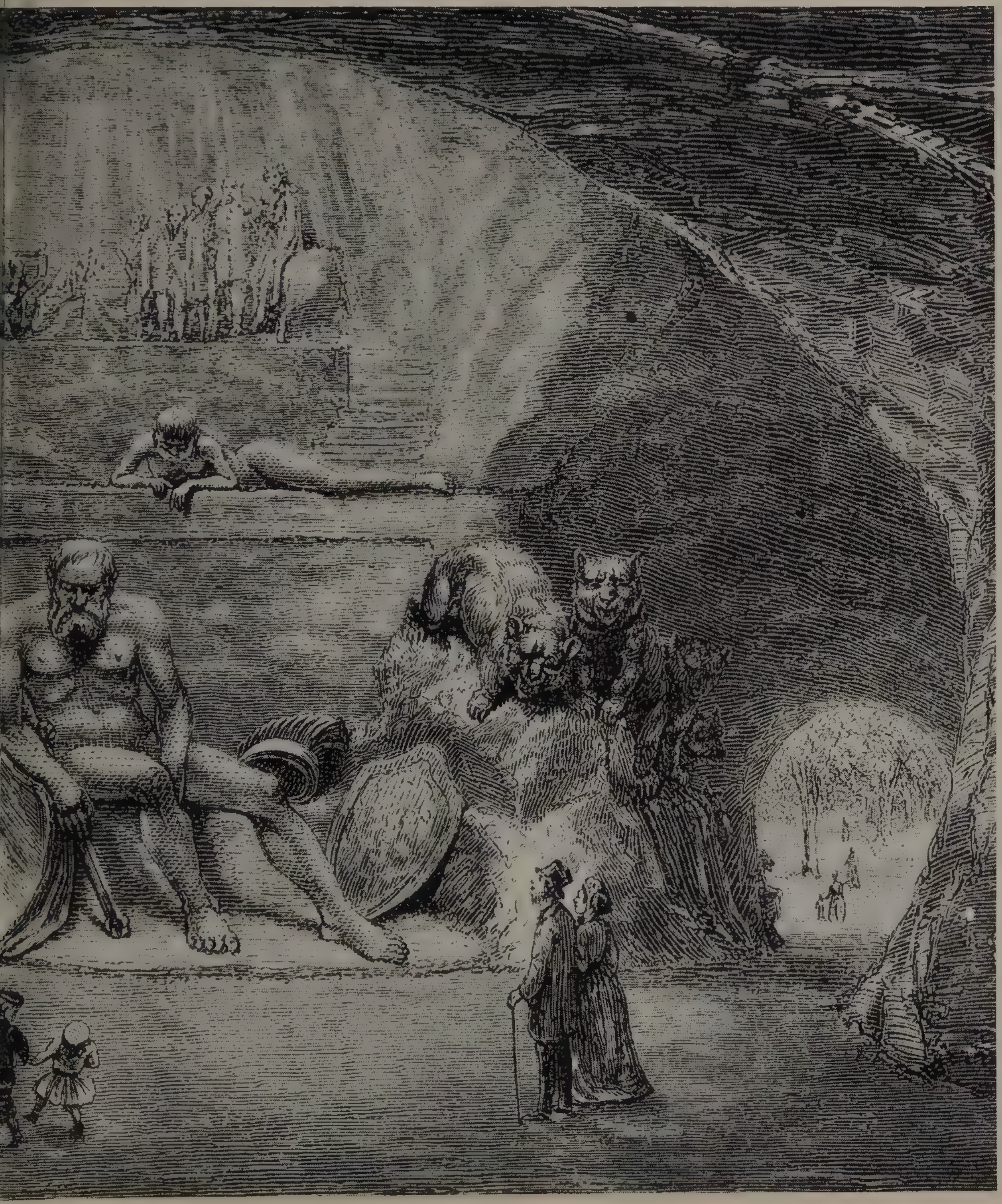


A map of Central Park from the park commissioners' 1868 annual report, far left. Left: Frederick Law Olmsted and Calvert Vaux's 1866 plan for a zoological garden and natural history museum in Manhattan Square, with an underground archway entrance from Central Park.
Both photographs AMNH

proposed archway, were intended to provide the public with an underground passage from Central Park into Manhattan Square.

At the main entrance, visitors would see a pair of "colossal stone figures" representing Ignorance and Superstition. Twenty-foot lions, tigers, and bears—symbolizing "the difficulties to be overcome before the student enters into the real enjoyment and comprehension of the beautiful"—guarded the second entrance. Once past these imposing statues, visitors would move along the subterranean walkway past a menagerie of "grotesque antediluvian animals of immense size" toward a large antechamber dominated by a seated figure, "the guardian genius of the place."

Then they would climb a flight of stone stairs into the museum proper and experience "the gradual progress of the world from barbarism to civilization." The logical culmination of this evolutionary journey was to be a gallery filled with artistic depictions of "the famous characters of recent times…our statesmen, soldiers, orators, and poets, the type of a perfect civilization."



Beard's museum never moved beyond the planning stage because of two major complications: the death at age fifty-one of Keep, the project's chief benefactor, in July 1869, and the rise to power of William Marcy "Boss" Tweed and Tammany Hall, a political emergence that also brought to an end the earlier plans of Olmsted and Vaux. Tweed was a figure of immense power, controlling both the State House and City Hall from his position in the state senate. For a time, the Tweed Ring even took over the administration of Central Park. Olmsted and Vaux were discharged as chief landscape architects, and plans for all building operations in the park, including the zoological gardens and Beard's museum in Manhattan Square, were rescinded, changed, or ignored.

Ironically, Tweed's total control of political power in the state contributed to the eventual success of Bickmore's plan. To purchase European collections of natural history specimens for the institution in 1868 and 1869, Bickmore had enlisted the support of a number of wealthy and influential New Yorkers, including Theodore Roosevelt, Sr., Joseph Choate, Morris K. Jesup, and J. Pierpont Morgan. They petitioned the legislature for a charter incorporating a museum and library of natural history "for the purpose…of encouraging and developing the study of Natural Science [and] of advancing the general knowledge of kindred subjects, and to that end of furnishing popular instruction and recreation."

Through the intervention of Samuel Tilden, later a reform governor of New York but at that time chairman of the Democratic State Committee, Bickmore secured a letter of introduction to Tweed in the state senate. Recognizing the influence of Bickmore's backers and responding favorably to Tilden's support, Tweed swiftly shepherded the proposal through the legislature, obtaining for the American Museum of Natural History an official state charter on April 6, 1869.

Two years later, the legislature approved the joint petition of the American Museum and the Metropolitan Museum of Art (which had obtained its charter in 1870) for permission to build suitable facilities to house their respective collections in Central Park. The commissioners designated Manhattan Square as the site for a structure that would jointly house the two museums and, despite protests from the trustees of both institutions, had the land graded and prepared for construction.

Before construction could begin, however, the Tweed Ring was overthrown. The previous park commissioners were reinstated, and Olmsted and Vaux came back to oversee the further development of the park. With the sympathetic support of the new administration, the Metropolitan Museum of Art negotiated its present site on the east side of Central Park at Eighty-first Street. The American Museum of Natural History chose to remain on the west side in Manhattan Square.

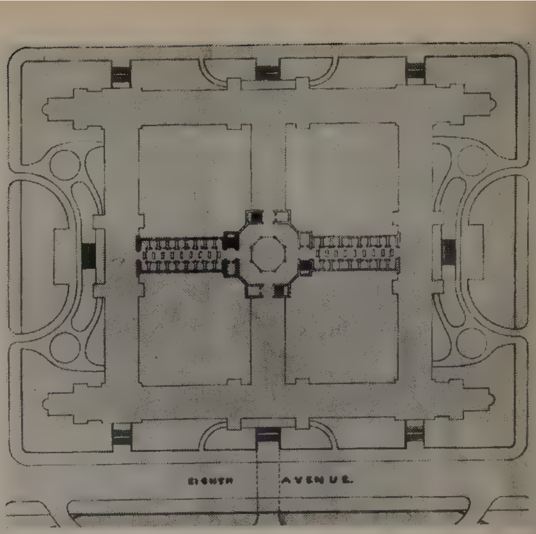
Despite his delight at the city's approval of plans for a museum, Bickmore had misgivings about the site. Writing many years later, he recalled that in 1871,

> within the boundaries of our area the prospect was most desolate and forbidding.... In the southern and central part of the square, just where the first section of our building was to be erected, was a...hill, whose crest rose as high as the ceiling of our present Hall of Birds. As I sat on the top of this rock, the surrounding view was dreary and my only companions were scores of goats.... On the west were only shanties perched on rough rocks, and south of us there was no building near, except the "Dacotah," a fine apartment hotel at the corner of Central Park West and Seventy-second Street.

Bickmore's pessimism was short-lived, however. At the trustees' request, Calvert Vaux and his associate J. Wrey Mould replaced the original plan for a modest, two-story museum building with an ambitious design—740 feet on each side—that encompassed the entire square. A domed tower in the center of four inner courtyards was reminiscent of the one in Bickmore's 1865 design. The buildings, faced with red granite, would have four floors of exhibits and a fifth floor for curators' work space. The section that went up first, beginning late in 1872, was about one-fourteenth of the proposed building. By the time the cornerstone was laid, the foundations and the walls of the first floor had been put in place. As President Grant daubed mortar on the foundation with a silver trowel, Governor John Adams Dix expressed his lofty hopes for the future:

> I know no locality so suitable for this, for such a Museum.... Most of us remember when, but a few years ago, this whole district, which now forms the Central Park, was an unsightly and shapely mass—"*rudis indigestaque moles*." Now it is the very miracle of rural beauty, where the most unpromising and stubborn natural feature has been made to blend and harmonize with the general aspect of order and grace.

By 1894, when the Museum celebrated the twenty-fifth anniversary of its charter, both Governor Dix's ambitious projections and Albert Bickmore's dreams had been fulfilled. Manhattan Square had been transformed from a rocky, rutted goat pasture into an international center for research and scientific education. □



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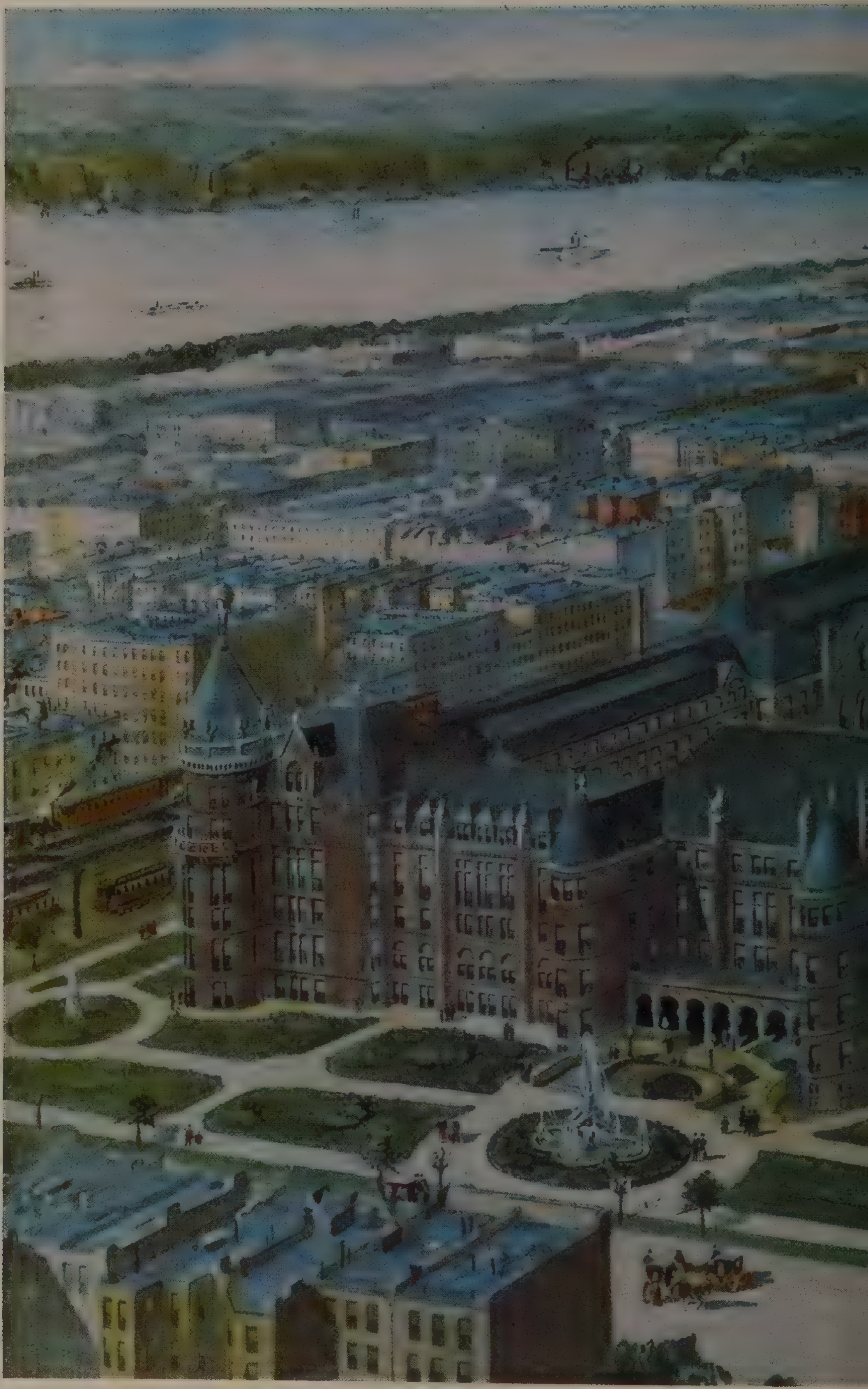

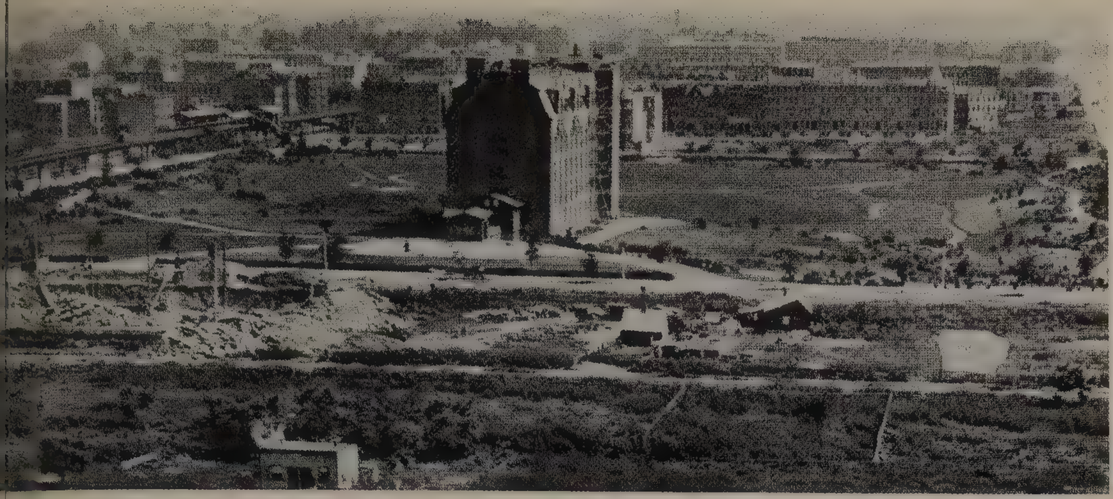

Collection of the New-York Historical Society

In 1871, Vaux and Mould drafted a master plan for the Museum, far left, but only one of the sections was completed, left. Architects Josiah Cleaveland, Louis DeCoppet Berg, and Milton See submitted a perspective rendering, below, in 1888, incorporating Vaux and Mould's motif of a Greek cross, but only the 77th Street side of their proposed building (foreground) was built.

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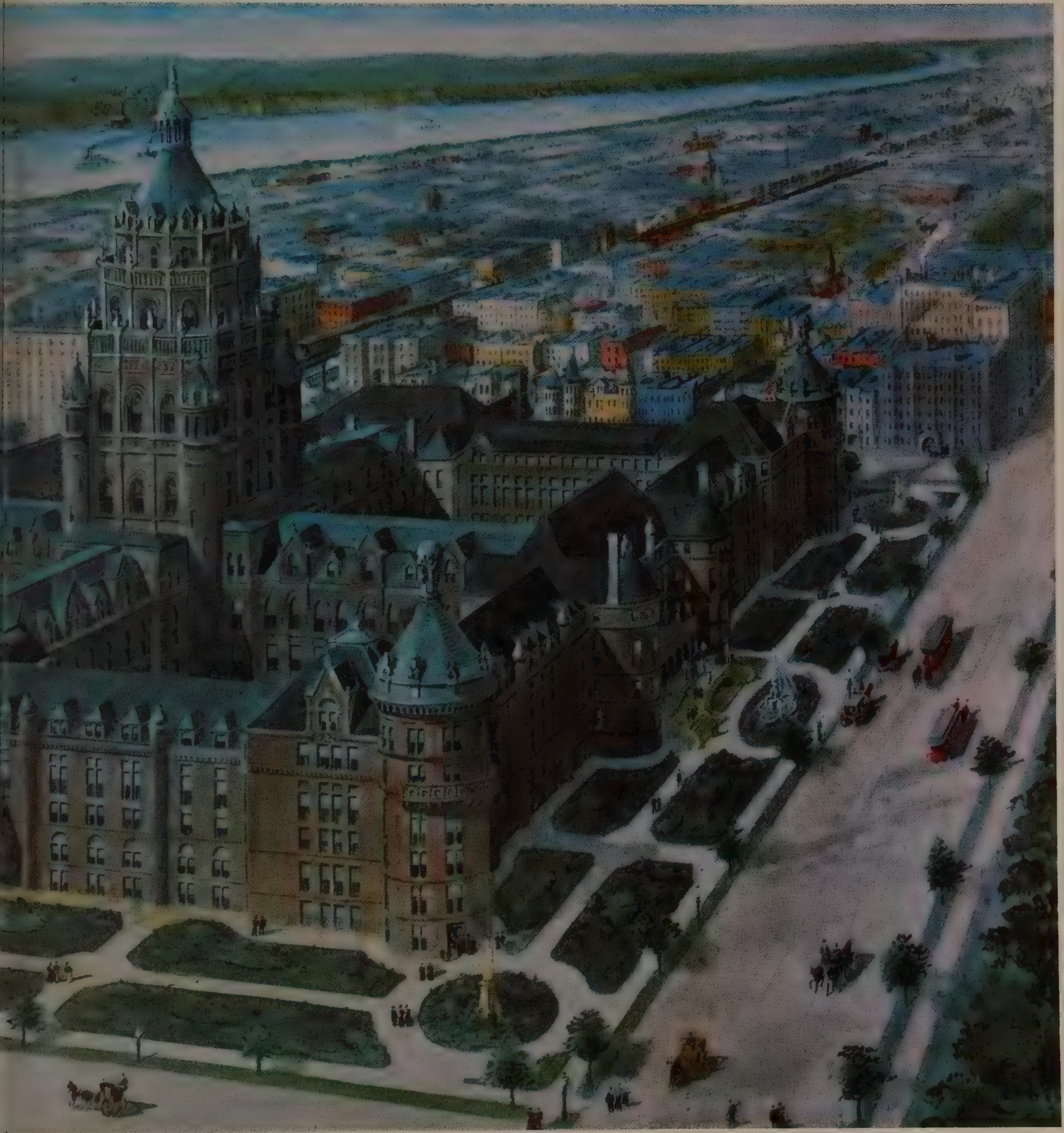

I Have a Dream

Gypsy Witch 1; Freud 0

by Roger L. Welsch

Psychologists say we all dream and that we all dream every night. No doubt they're right, although I rarely recall my dreams—but then, I can hardly manage to recall why Linda sent me to the grocery store only moments after she's sent me. What's curious about the dreams I do remember the next morning is that the inventory is remarkably thin—a total of maybe three. And they are all bad. Just my luck.

Roger Dream Number 1: I open my mail to find that someone has finally discovered that I served only six years and seven months of my seven-year military obligation back in the bad old days. I show up at my base and am standing there in the ranks…but I cannot find my cap. So, there I am, at attention without my cap, knowing that Sergeant Ericson is going to ream me but good, just as he always did. (I often wonder if Sergeant Ericson maybe has the same dream but smiles in his sleep.)

Roger Dream Number 2: I suddenly remember that school is about to start—although in real life I haven't taught in a classroom for more than seven years. Sometimes I am allowed a couple of days before I step into the class, but other times I am in my office and the bell is about to ring. I realize that not only have I not prepared my lesson plans but that I also don't know where I've put my transparencies—a professorial nightmare indeed.

Roger Dream Number 3: I am about to return home from Europe from a field trip for the Smithsonian Institution (I frequently went on these trips twenty years ago). The train is leaving in a matter of minutes for the city where I am to catch my plane, but I have lost my room key and forgotten my room number. I will never get everything thrown together in time. Sometimes I eventually find my key, remember my room number, and make it to the airport all right, but as I stand there watching my luggage go up a carousel ramp, I realize that I have packed my ticket and passport in the luggage, which is about to go onto the plane—and home—without me.

What's uncanny about these dreams is that I am always in the exact same room, hangar, hotel, or airport. I don't know if these places really exist, but I know them like the back of my hand after years of sweating out the complications of my dreams in these settings. My dreams never contain any surprises.

The real mystery to me, however, is the contrast between my dreams and my wife's. I am big, loud, brash, opinionated, independent, and blunt; I dream about losing my cap, hotel key, or passport. Linda is shy, quiet, gentle, uncertain, and subtle; she dreams about distant planets where fire-breathing gorgons with coppery teeth fight wars, tearing great hunks of flesh from their extragalactic enemies and throwing the pieces they do not eat themselves down long Martian cliffs to packs of green, screeching centaurs who pound the still quivering flesh into the pink soil.

When Linda struggles and groans in her sleep and I wake her up, she tells me about horrors that only special-effects experts can dream up. I, noting that such scenes are clearly outside any conceivable realm of possibility, say, "There, there" and go back to sleep.

On the other hand, when I wake up screaming and kicking the finials off the footboard of our bed and explain to Linda that I had this terrible experience of thinking I packed my passport in my suitcase and checked it in prematurely, Linda says, "Poor baby. At least the airport was in this solar system," laughs out loud, and goes back to sleep.

What would Freud have said about my dilemma? "Forbidden desires cloaked in symbolism"? Maybe in Sergeant Ericson's dream, but not in mine (Sarge always seemed to take special delight in calling attention to my shortcomings). "Resolution or relief of fear and anxiety"? When I wake up moaning and yelling because of a dream, our dog Lucky runs out of his sleeping porch, barking at the primal

sounds emanating from the house above, and I spend a good part of the rest of the night calming him down and persuading Linda not to start him up again by laughing too loud. I suspect that even Freud wouldn't find many tantalizing secrets buried in my unconscious. "Herr Velsch," he would say, "my analyziz zuggests, take it a liddle easier on de barbecue zauce next time you pig out on ribs."

One of the first books I remember encountering in my parents' home was *The Gypsy Witch Dream Book: New and Revised, Complete and Up-to-Date,* by the Queen of the Romanies (which beats the living heck out of "Sigmund Freud, M.D."). Whenever I consulted the book fifty years ago to interpret the hidden meanings of my own dreams, I was impressed by how goofy the Gypsy interpretations seemed to be—as I was to learn later, right up there with Freud's. Since I've never thrown the book away (I've never thrown anything away), in desperation I decided to turn to it once again for some idea of what is going on in my tortured nocturnal psyche.

I dug out *The Gypsy Witch Dream Book,* still mysterious in its plain black binding after all these years. It had "reindeer" and "rhinoceros," "stovepipe" and "lemonade," but nothing under "passport," "lesson plans," "airport," or "Sergeant Ericson." But whoops, what was this? "Lose: to dream of losing anything foretells sorrow and remorse." Yep, that was it, all right. When I dream about losing my cap, passport, or lesson plan, everyone from Lucky to Linda is filled with sorrow and remorse.

Eagerly, I read on: "To lose your hat or cap can be an unpleasant experience…but you'll have to admit, it beats fire-breathing gorgons and green, screeching centaurs. And, by the way, next time you dig into the ribs, take it easy on the barbecue sauce."

Folklorist Roger L. Welsch lives on a tree farm in Dannebrog, Nebraska.

American Museum of Natural History

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Crash Landing on Jupiter

by Gail S. Cleere

This month, fragments of Comet Shoemaker-Levy 9 will smash into Jupiter's atmosphere at a speed of 133,200 miles per hour. Scientists calculate that some of the resultant explosions will be equivalent to the detonation of 200,000 megatons of TNT—more than the force of all the world's nuclear arsenals. The combined effects of the collision of the twenty-one or more fragments could equal the energy level of the great Yucatan impact on our own planet sixty-five million years ago, a catastrophe that ended the age of the dinosaurs. The action will take place over a seven-day period, from July 16 through July 22.

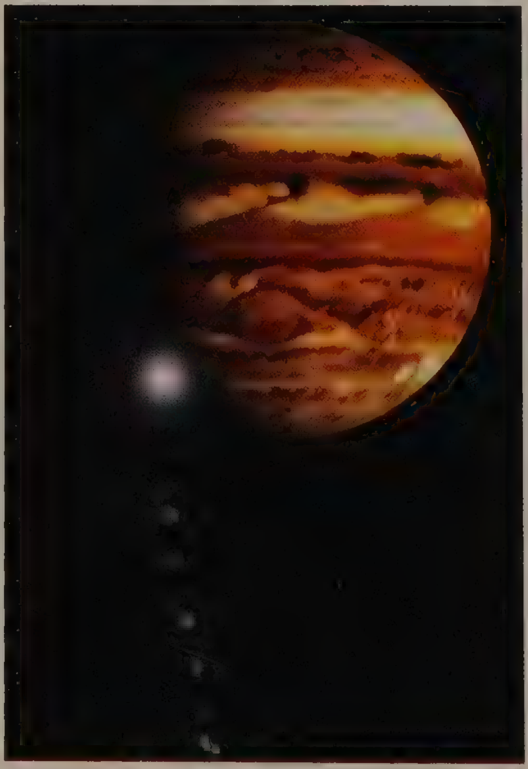
Originally, the comet may have measured from one to six miles in diameter and the estimates of its largest fragments, which are now stretched out in a procession three million miles long, are equally uncertain. From the earth, the chain appears to be roughly half the size of the moon's angular diameter (twenty arc minutes of the sky).

Since its discovery in March 1993, Comet Shoemaker-Levy 9 has attracted the attention of astronomers around the world. It is one of a handful of comets known to orbit Jupiter, instead of the sun, and it is the only one actually observed in orbit (the paths of others were determined from their motion). Brian Marsden, an astronomer at the Harvard-Smithsonian Astrophysical Observatory, believes the comet was drawn away from a solar orbit in the early 1970s by Jupiter's strong gravitational pull. Given its current orbit, the comet must have made a close approach to the massive planet in July 1992, passing just 13,000 miles above Jupiter's cloudtops. Immense Jovian tidal forces caused the comet to crack, crumble, and fly apart. The pieces then spread out in a line as they continued in their orbit.

Other comets have been observed in the act of breaking apart, but in this case the real excitement comes from the prediction of the comet's imminent demise. Just after the comet's initial discovery, Marsden and Paul Chodas, of NASA's Jet Propulsion Laboratory, calculated its orbit. They found that the comet would crash into Jupiter on its next close approach, in the summer of 1994.

"The planetary science community is very excited about this event," says Hal Weaver, of the Space Telescope Institute in Baltimore. "Luckily it's not happening to us, so the bigger the better." Jupiter will take its hits on its dark, far side, just out of sight of earth-bound observers. Each impact will take place some five to nine degrees behind the planet's eastern edge. Because of Jupiter's rapid rotation, each impact site will become visible from the earth in only twenty to forty minutes after the crash; another seventeen minutes will pass before each site crosses into sunlight.

The *Galileo* spacecraft, due to reach Jupiter in 1995, will have fine views of the impact explosions, but the earth-orbiting Hubble Space Telescope will not be in a position to see the collisions. (It will, however, be able to monitor atmospheric changes on the planet.) The sun-orbiting *Ulysses* spacecraft will have a view of some of the collisions and will be able to monitor the impacts in radio wavelengths. Both *Voyager* spacecraft, now on their way out of the solar system, might have observed the impacts had their cameras not been turned off. There is now too little time for NASA to restore these on-board cameras.



An artist's rendition of the upcoming destruction of Comet Shoemaker-Levy 9. Seen from the perspective of the Galileo *spacecraft, the cometary fragments slam into the dark side of Jupiter.*

D. A. Seal; Jet Propulsion Laboratory

Astronomer Reta Beebe, of New Mexico State University, explains, "All the action will happen about forty to forty-five degrees south latitude," just below Jupiter's Great Red Spot. "This region has no outstanding, long-lived cloud structures like the Great Red Spot, but it is actually quite a turbulent, cyclonic region on the planet, where clouds tend to come apart." After impact, each cometary fragment will blow up not far below Jupiter's cloudtops, and the hot gas that results (54,000° F) will create a huge fireball similar to a nuclear explosion. According to the computer models, the descending fireball will dig itself a chimney and blow itself back out. There is a slim chance that the later impacts will eject material high enough to be visible even to those with backyard telescopes who are familiar with Jupiter's normal appearance.

At the time of this writing, the fiery end of Comet Shoemaker-Levy 9 is expected to begin at approximately 3:30 P.M., EDT, on the 16th. As the sky darkens, look in the southwest for the striking configuration of Jupiter, the waxing gibbous moon below, and Virgo's bright star Spica to the west. As the cometary collision draws near, check local papers or astronomy publications for updates on the timing.

THE PLANETS IN JULY:

Mercury is now moving into the early morning sky and may be seen, although with some difficulty, to the east–northeast in the dawn twilight. On the 7th, the planet is about two moon widths below a slim crescent moon. At the end of the month, Pollux, in Gemini, can be seen twinkling just above Mercury.

Venus moves lower in the southwestern sky, where it is visible just after sundown. What the planet lacks in position, however, will be made up in brilliance as it moves toward its greatest elongation east of the sun. On the 10th, Venus is one degree above the bright star Regulus, in Leo. On the 11th, Venus will be riding high above the thin crescent moon.

Mars has moved into Taurus and can be seen rising about three hours before the sun. On the 5th, Mars will be positioned about five moon widths above and to the right of the crescent moon. By midmonth, the red planet rivals the reddish star Aldebaran, which is just below it.

Jupiter is past the meridian (the arc of sky stretching from due south to due north) as the sun sets. On the 16th, as the planet is hit by the first fragments of Comet Shoemaker-Levy, look for the giant planet about six moon widths above and to the left of the waxing gibbous moon.

Saturn rises before midnight among the faint stars of Aquarius and by dawn is well placed in the southern sky. On the 25th, the ringed planet is seen well below and slightly to the right of the waning gibbous moon.

Uranus and **Neptune** are both at opposition this month (seen opposite the sun in the sky), rising as the sun sets and setting as the sun rises. Using binoculars and a detailed sky chart, you have a chance of spotting these two blue-green worlds just east of the constellation Sagittarius.

Pluto remains in Libra, plodding along at about 7,000 miles per hour not far from the bright stars of Scorpius. When looking in the direction of Pluto, we face the center of our Milky Way galaxy.

The **Moon** is new on the 8th at 5:37 P.M., EDT, and reaches first quarter at 9:12 P.M., EDT, on the 15th. The full moon occurs on the 22d at 4:16 P.M., EDT, and last quarter occurs on the 30th at 8:40 A.M., EDT.

Gail S. Cleere lives in Washington, D.C., and writes on popular astronomy.

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The exhibits will be on display in the Library Gallery through January 1995. The Gallery is located on the fourth floor and is open Monday through Friday, from 10:00 A.M. to 4:30 P.M.

THE APOLLO ADVENTURE

On Wednesday, July 13, Andrew Chaikin, author of the recently published *A Man on the Moon,* will present "An *Apollo* Retrospective," the scientific findings from the first manned moon landing. On Thursday, July 21, Peter G. Wilhelm, director of the Naval Center for Space Technology, will discuss what has happened since *Apollo* in "Project Clementine: A Return to the Moon." Both lectures, part of the "Frontiers in Astronomy and Astrophysics" series, begin at 7:30 P.M. in the Sky Theater. Tickets are $8 ($6 for members).

"Man on the Moon: The *Apollo* Adventure," the Planetarium's special exhibition marking the twenty-fifth anniversary of the *Apollo 11* moon landing, will run through the end of September. Featured are a model of the original *Apollo 11* lunar module, *Eagle;* a full-size replica of the Lunar Rover; and memorabilia from the *Apollo* flights. The award-winning film *The Eagle Has Landed* will be shown continuously at the exhibition. For information about all Planetarium events, call (212) 769-5900.

These events take place at the American Museum of Natural History, Central Park West at 79th Street in New York City. The Museum has a pay-what-you-wish admission policy. For more information about the Museum, call (212) 769-5100.

Martin Johnson (center) is one of the many photographers whose work is featured in the Library's exhibition, "The World Explored."
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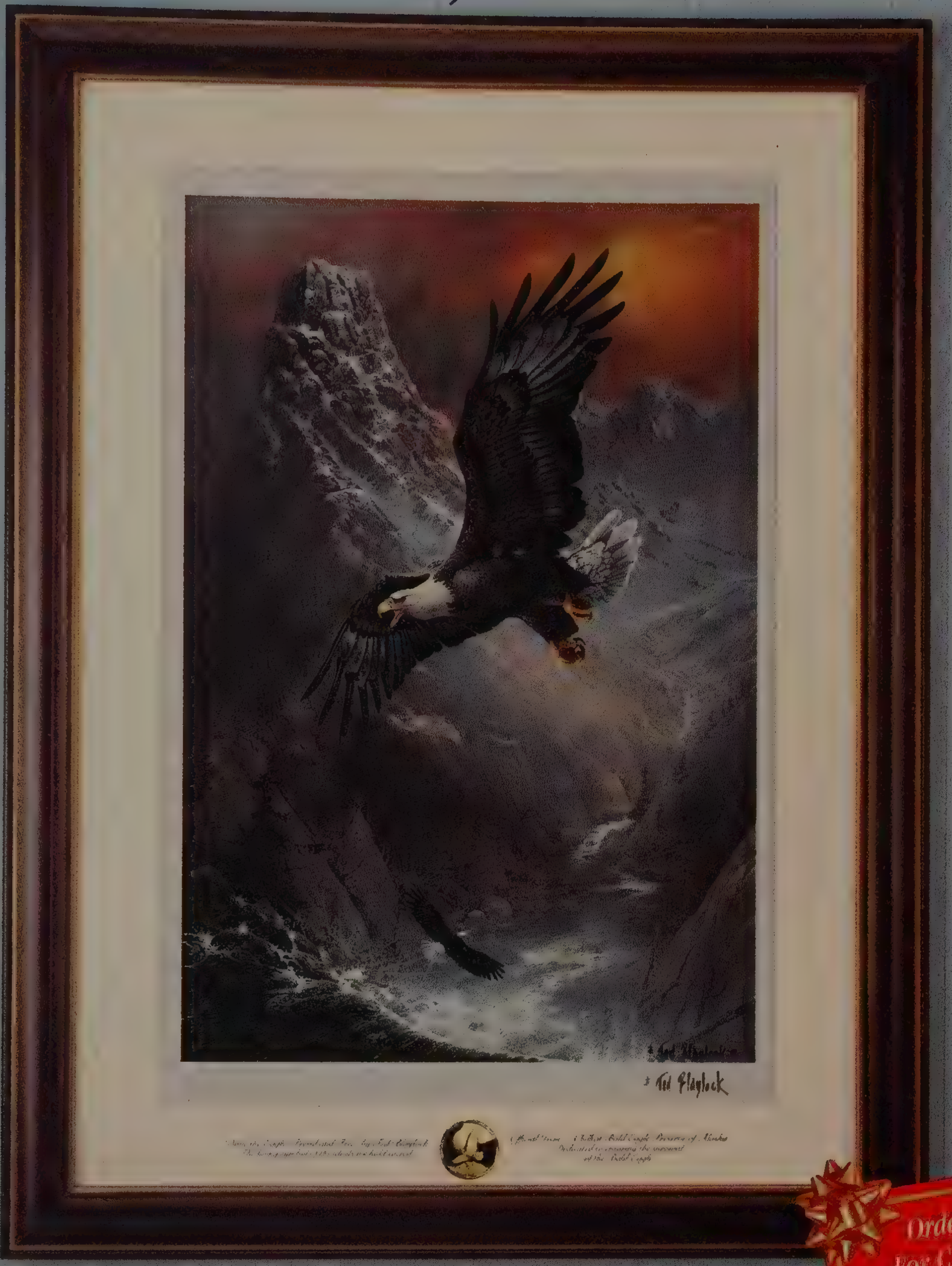

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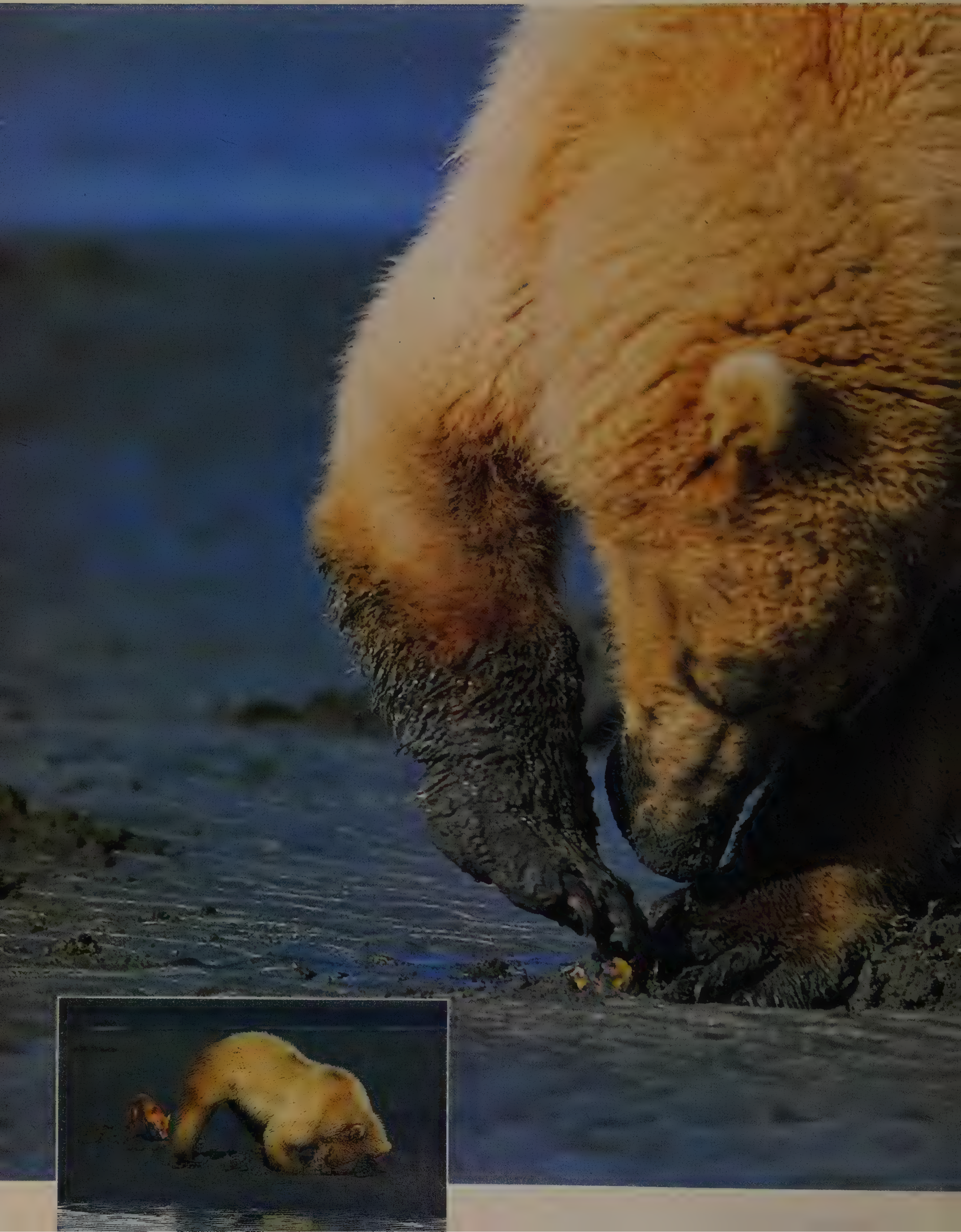
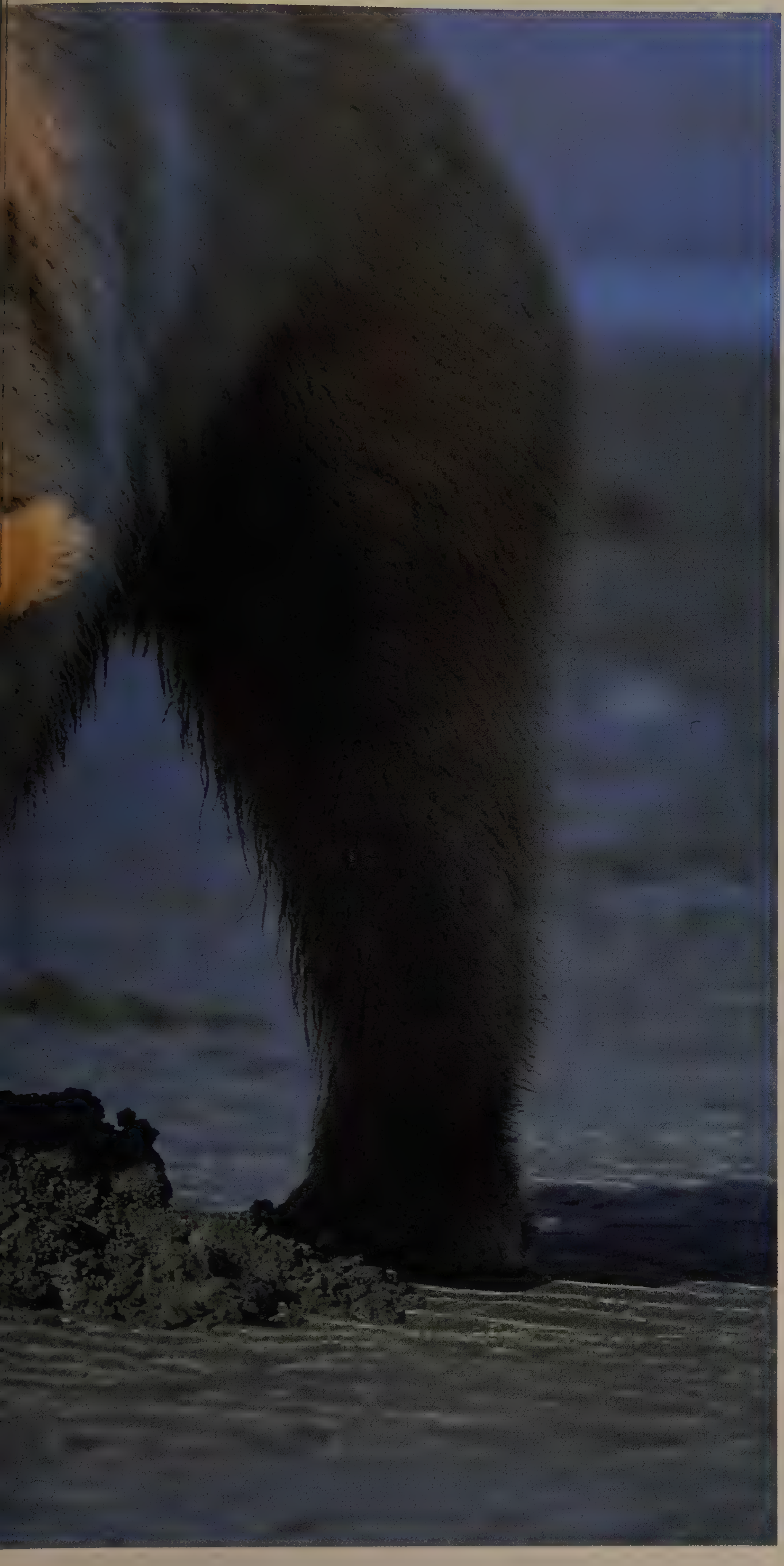




Raw Bar

In early summer, an Alaskan brown bear attempts to open a razor clam it has excavated from a sandbar on the Katmai coast. Standing on the clam with one foot, the bear delicately pries the halves of the shell apart with its claw to expose the meat (other bears use their teeth to crush clams). After slurping down the contents of the shell, the bear moves on, nose to the ground, looking for more food. The razor clam's half-foot-long neck may just be visible at the surface, but when the bear grabs for it, the clam retreats farther into the sand, making the predator dig for its meal. Only occasionally does the bear snag the prey before it retreats into the muck. Foxes (inset), seagulls, and other animals often follow closely behind clamming bears, picking over the discarded shells for scraps.

For the bears, the clams are more than an occasional treat. During the four hours or so that the tides left this sandbar exposed, this bear left a trail of more than one hundred holes; each had yielded a razor clam. Until the salmon runs begin at the end of the summer, the mollusks provide a welcome source of protein to augment the sedge grass that the bears graze on in the coastal meadows.—*R. A.*

Photographs by Will Troyer

AUTHORS

“My unwavering interest in shells began at the age of ten, when my fourth-grade teacher brought Florida shells to us in Dover, New Jersey,” says ecologist-geologist **Geerat J. Vermeij** (page 32), who has been blind since the age of three and uses touch in the study of marine life. “These clam and snail shells, many adorned with neatly arranged ribs, knobs, and even spines, were so vastly prettier and more elegant than the chalky (although still nice) shells I had known in the Netherlands that I resolved to collect and study them.” In 1968, he graduated from Princeton University, where he majored in biology, and then went on to earn his Ph.D. from Yale University. Now a professor at the University of California at Davis, Vermeij continues to do fieldwork throughout the world, especially in Guam and other parts of the western Pacific. The evolution of labral spines (sharp downward protrusions) in predatory snails is one of his current research interests, as is his formulation of a history of life based on the “market” forces of risk, reward, benefit, cost, supply, and demand. For additional reading, Vermeij recommends *Extinct Birds,* by E. Fuller (London: Viking/Rainbird, 1987) and his own 1991 article “When Biotas Meet: Understanding Biotic Interchange,” in *Science,* vol. 253, pp. 1099–1104.

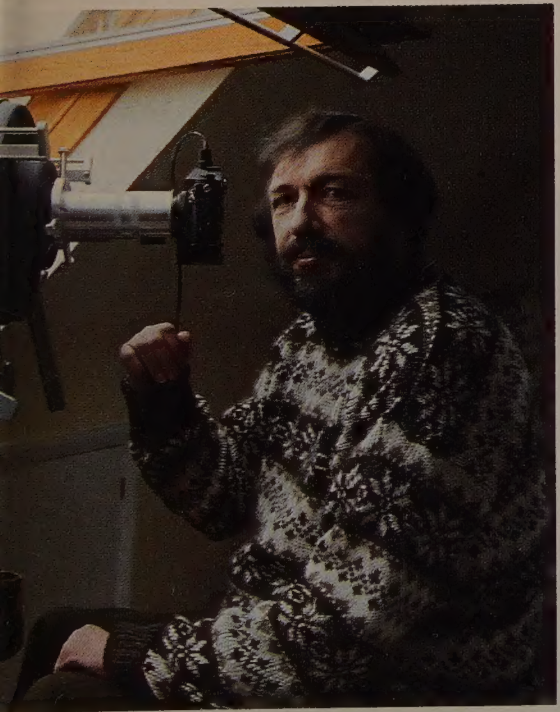
“As an anthropologist,” says **Eugenie C. Scott** (page 10), “I have done fieldwork in rural Kentucky, in Belize, and on Florida’s Seminole Reservation, but in my present job I work in the fields of television shows, radio talk shows, and teacher conferences.” Executive director of the National Center for Science Education, located in Berkeley, California, Scott studies the activities of the religious right and scientific creationists and helps teachers around the nation keep evolution at the core of the science curriculum. She finds her work satisfying but is often dismayed by the extent of scientific illiteracy in America. For additional reading she recommends *Science and Earth History: The Creation-Evolution Controversy,* by Arthur Strahler (Buffalo: Prometheus Books Publishing Co., 1988); *The Creationists,* by Ronald Numbers (New York: Alfred A. Knopf, Inc., 1992); and *The Creationist Movement in Modern America,* by Raymond A. Eve and Francis B. Harrold (Boston: Twayne Publishers, 1990).

LIBER
BAPTIST

By day, **Tony Holley** (page 42) is a partner in a law firm in Somerset, England, but his evenings are reserved for watching foxes stalk hares in the nearby countryside. The foxes, it seems, win less often than most people imagine. Holley qualified as a solicitor in 1954. Almost forty years later, in 1992, at the age of sixty, he completed his doctorate in zoology at Durham University, working first on the gulls of Bridgwater Bay, and later on the behavior of the brown hare. He writes that “hares are particularly obliging subjects for a researcher who is also involved in a full-time nonscientific profession. Virtually the whole time the researcher is sitting at his lawyer’s desk during the day, the hares are lying motionless, asleep. They become active just before dusk, when the researcher can watch them comfortably from the attic windows of his country home.” For the general natural history and folklore attached to the brown hare, Holley recommends *The Leaping Hare,* by G. E. Evans

Although he had originally planned to write a dissertation on archeology in Ireland, **Christopher P. Toumey** (page 4) was so disturbed to read about the rise of creation "science" that he decided to do an ethnographic study of the modern creationist movement. A book based on his doctoral research has just been published: *God's Own Scientists: Creationists in a Secular World* (New Brunswick: Rutgers University Press, 1994). Toumey, a visiting lecturer in anthropology at the University of North Carolina, Chapel Hill, also teaches at a maximum security prison in Raleigh, North Carolina. He is currently writing a book on science in American life, including theories of AIDS/HIV infection, the fluoridation controversy, and cold fusion. For additional reading, Toumey recommends *Anti-Evolution,* by Tom McIver (Jefferson: McFarland, 1988), and *The Evolution Controversy in America,* by George E. Webb (Lexington: University of Kentucky Press, 1994).

and D. Thomson (London: Faber, 1972) and "Pursuit-deterrent Signals: Communication between prey and predator," by O. Hasson in *Trends in Ecology and Evolution,* vol. 6, pp. 325–29 (1991).



In 1984, when astronomer **Li Weibao** (page 54) compiled the astronomy annals of Yunnan, he discovered the customs associated with the ancient calendar of the Yi people. "These traditions were on the verge of disappearing," writes Li, "but I felt that it was a national and historical responsibility to preserve them." Born in Yunnan Province, Li earned a physics degree from Beijing University in 1973 and then an advanced degree from the University of Science and Technology in Hefei, Anhui Province. For many years, he has studied sunspots and continues this research at the Yunnan Observatory, along with additional documentation of the history and culture of minority groups. Chinese history and classical poems and songs intrigue Li, as do traditional Chinese paintings and calligraphy. Unfortunately, recommending additional reading about the Yi calendar in English is virtually impossible. For those who can read Chinese, however, Li suggests *A Collection of Ancient Chinese Astronomical Phenomenon Records* (1988), published by Tiansu Science and Technology Publishing House.

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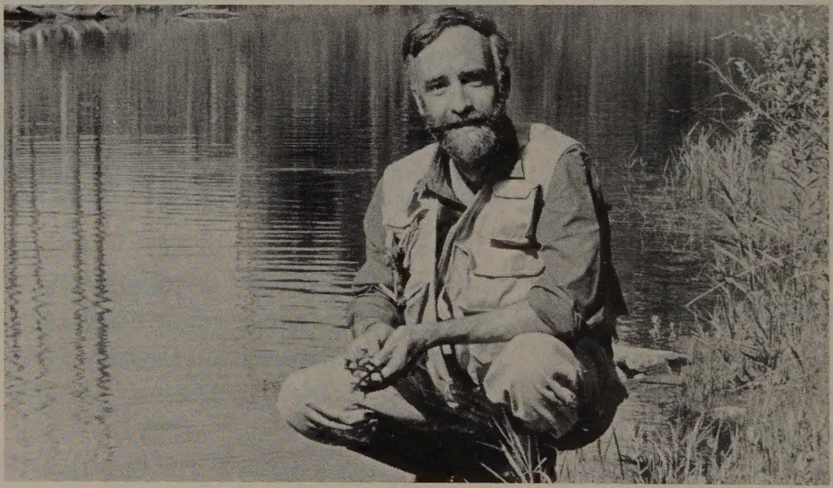
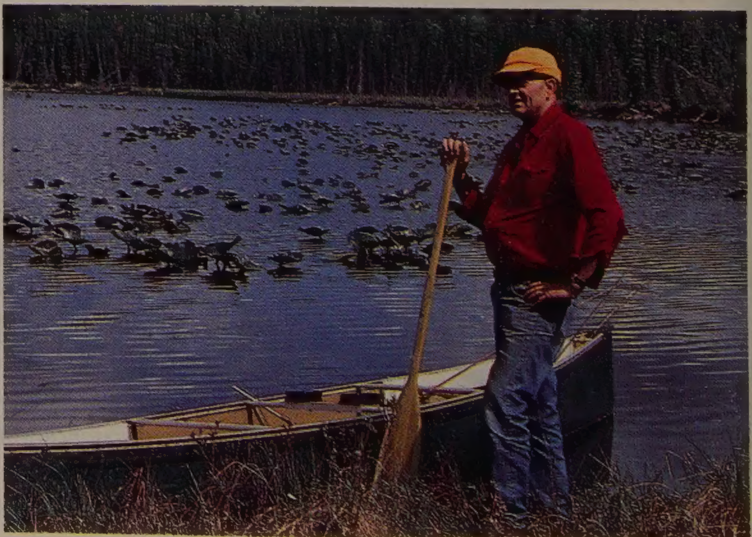
On a summer day in 1981, **Jerome A. Jackson** (page 46) stopped for lunch at a local mall and noticed the unusual least tern traffic there. Since then, Jackson, a professor of biological sciences at Mississippi State University, and his students have monitored the terns nesting on the mall rooftops and have also been actively involved in efforts to protect terns nesting on beaches. Jackson served for eight years as the head of the U. S. Fish and Wildlife Endangered Species Recovery Team working to save the red-cockaded woodpecker of southeastern forests. He has searched for evidence of the ivory-billed woodpecker in Cuba (perhaps the only place on earth where the bird still exists) and is now in the field in Indonesia. He has edited various scientific journals, including *The Wilson Bulletin,* and also enjoys bringing science to lay audiences. A frequent contributor to *Birder's World* magazine, for the past five years Jackson has also been co-host of a weekly television nature program, "Mississippi Outdoors." He is the coauthor, with Judith A. Toups, of *Birds and Birding on the Mississippi Coast* (Jackson: Mississippi University Press, 1987). For more information on terns in general, readers can turn to a popular classic, John Hays's *Spirit of Survival: A Natural and Personal History of Terns* (New York: E. P. Dutton and Co., 1974).

"Museums can tell us as much about the people (and societies) who make them as about the subjects they were designed to explain," says **Robert McCracken Peck** (page 62) by way of explaining how he became interested in the American Museum of Natural History. As Fellow of the Academy of Natural Sciences of Philadelphia, Peck has the enviable job of chronicling the collections of the nation's oldest continually operating natural history museum. When not accompanying Academy research expeditions to Asia, Africa, or South America, Peck lectures and writes articles, grant proposals, and books—his subjects have included John James Audubon, Louis Agassiz Fuertes, and William Bartram. Next year he will take a temporary leave of absence from the Academy for a fellowship at Harvard University, where he will study the life and art of Edward Lear (1812–1888). For further reading, Peck recommends: *Dinosaurs in the Attic,* by Douglas J. Preston (New York: St. Martin's Press, 1986), *The City That Never Was,* by Rebecca R. Shanor (New York: Penguin Books, 1991), and *The Park and the People,* by Roy Rosenzweig and Elizabeth Blackmar (Ithaca: Cornell University Press, 1992).



Will Troyer (page 76) poses with his canoe on the Katmai Peninsula, where he photographed the bear digging clams for this month's "Natural Moment." Troyer received his B.S. and M.S. in wildlife management from Oregon State College in Corvallis, and Montana State University in Missoula, respectively. After graduating in 1952, he immediately headed for Alaska, where he has worked as a biologist ever since—including twenty-three years with the U. S. Fish and Wildlife Service and seven with the National Park Service. In his early years, Troyer was one of a few biologists working on a diversity of species in the remote regions of the state. He pioneered techniques for trapping brown bears for scientific study (at first using a bucket of ether over the animal's head). Troyer has also conducted studies of caribou, moose, Dall sheep, bald eagles, and trumpeter swans. After his retirement in 1981, Troyer and his wife, LuRue, spent two and a half years building a log home near the Kanai Mountains, "where," he says, "I can watch Dall sheep and mountain goats from my deck." He keeps busy with photography, birding, fishing, and hunting, but confesses to leaving his beloved Alaska during the short winter days of December and January to photograph wildlife in such warm climes as Africa and Australia. To photograph the bear digging clams, Troyer used a Nikon camera with a 600mm Nikon lens.



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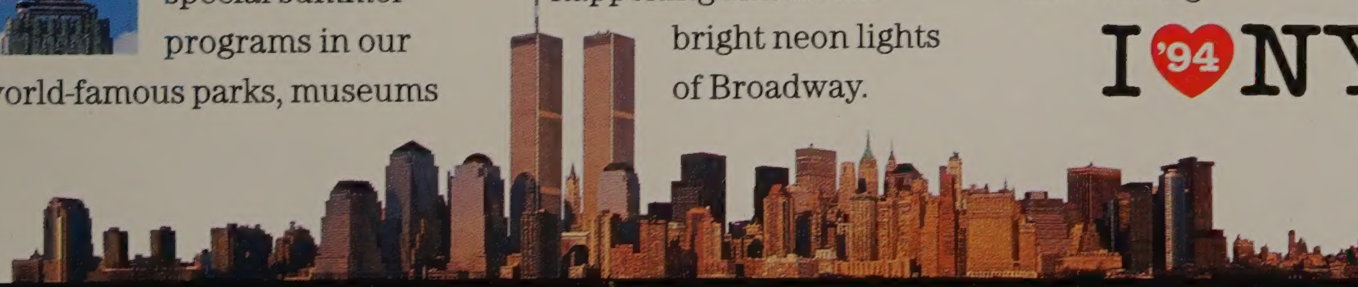

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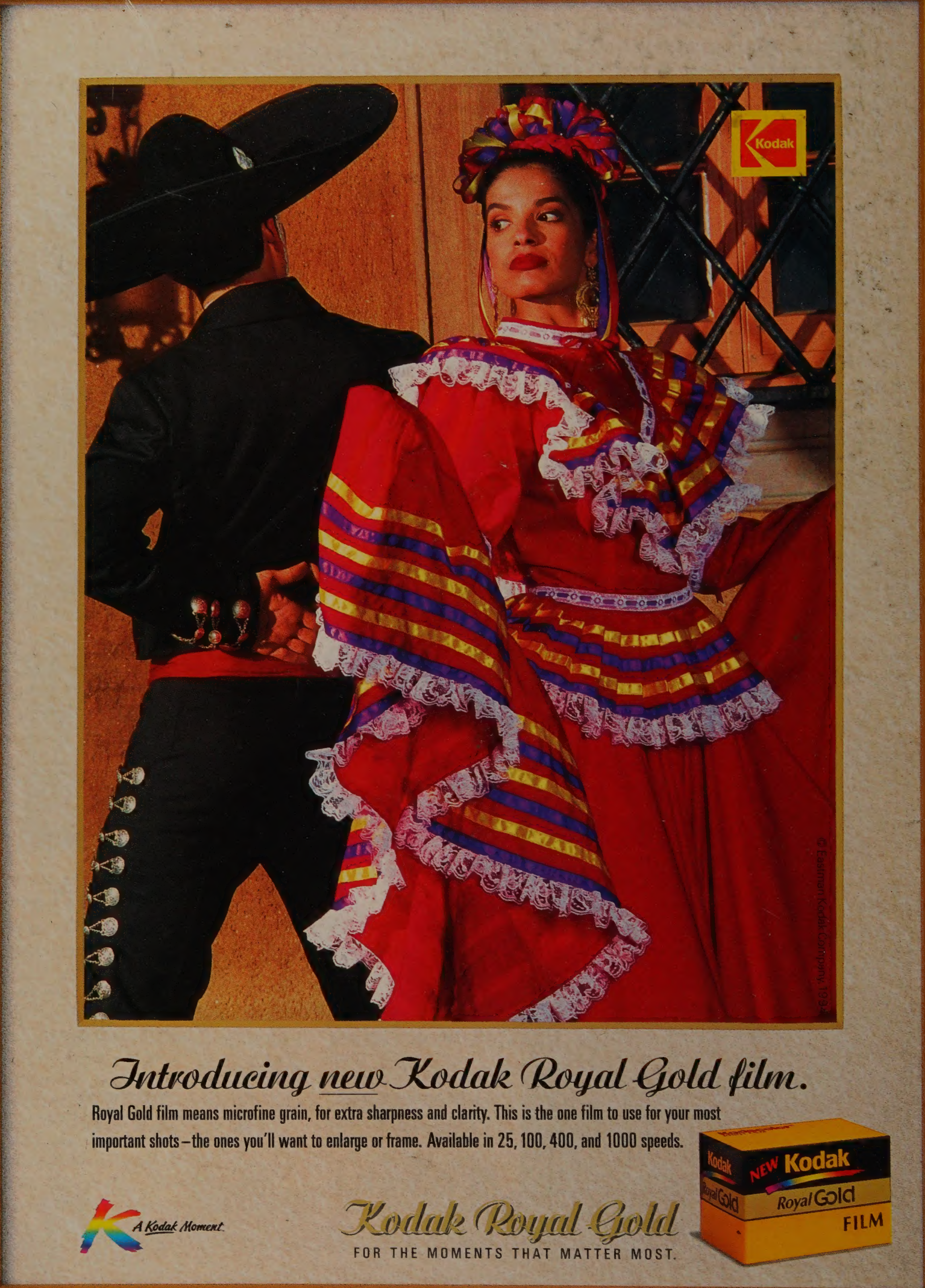
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